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Repairs To the U. S. Naval Dispatch Vessel "Dolphin"

(CONTRIBUTED)

The necessity for renewing, in steel ships, the structural work supporting the boilers occurs so frequently that it ordinarily excites no comment. Occasionally there are special conditions that render the work difficult, or through attendant circumstances and past history of the ship, such an incident presents unusual interest. This last is believed to be true of the "Dolphin," which is at the Brooklyn Navy Yard for extensive renewal of structural steel in the machinery spaces, due to its having corroded away.

The "Dolphin" was the first steel vessel constructed for the U. S. Navy and was laid down in 1883, being intended for use as a "dispatch vessel, capable of furnishing rapid communication from the seat of government to any point on the coast or the West India Islands," or, in case of the formation of a United States squadron, it was expected to act as fleet dispatch boat or flagship, the designers being governed by the desire to provide for a high speed capable of being maintained several days.

The extreme length of the ship is 257 ft.; the displacement at mean draft, 1500 tons; the designed speed, 15 knots; the designed indicated horsepower, 2300; the coal capacity, 310 tons; and the contract price, $315,000. The "Dolphin" was rigged, as shown in the first figure, as a three-masted schooner, and was provided with sails as such, though one of the masts and the sails were taken off many years ago. She was built by John Roach, of Chester, Penn., who built, also, the "Atlanta," the "Boston" and the "Chicago."

The first trials of the "Dolphin," in November, 1884, resulted in breaking the thrust section of the propeller shaft. This section was of steel and, as a result, it and other steel sections of the shaft were replaced with new ones of wrought iron. On the second trial, held in March, 1885, the engines failed to develop the collective capacity of 2300 hp. specified in the contract, showing a deficiency of 182 hp. from that required.

Despite the recommendation of the Naval Advisory Board that the vessel be accepted, the Secretary of the Navy, W. C. Whitney, declined to authorize the acceptance of the vessel and after some correspondence required the contractor to hold another trial. He appointed a special examining board at the same time to report as to whether the ship had been constructed in accordance with the terms of the contract. This board reported, after three trials, on one of which she grounded, their opinion that the "Dolphin" had not the requisite strength and stiffness to enable her in all weather to make the speed required by the contract, nor the necessary power to make the specified speed of 15 knots in all weather. After considerable correspondence, the acceptance of the "Dolphin" was authorized in 1885, but the determination as to whether full payment, stipulated in the contract, should be made was left for settlement by the courts. In the meantime the contractor had made an assignment

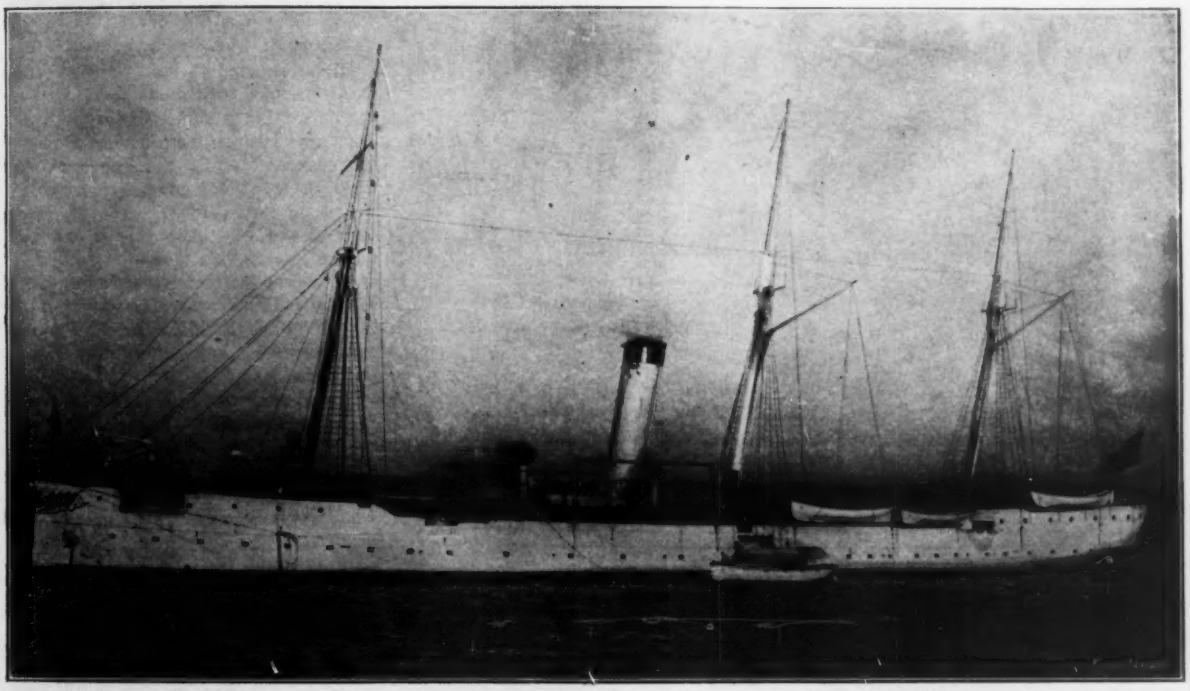


FIG. 1. U. S. S. "DOLPHIN" AS APPEARING WHEN FIRST BUILT

(Since then the mainmast and sails have been removed and the rig correspondingly changed.)

in bankruptcy, due probably to financial difficulties consequent on not having the "Dolphin" accepted and paid for. The whole transaction had the appearance of being inspired by politics, and it was so charged freely. Considerable recrimination was indulged in and some persons to this day harbor resentment caused by the episode.

The seaworthiness of the "Dolphin" and the strength of her construction and the satisfactory qualities of the materials used have been amply demonstrated in the course of her long service.

The work for which the vessel is now laid up is due primarily to her age and service, though some of it may be attributed to the design, which rendered part of the structure around the boilers inaccessible. At any event it may be considered to be rather remarkable, when the age of the ship is considered, that the structure has lasted so long.

From time to time for a number of years, patching the steel work has been done when the ship could be spared from service. In the fall of 1911 the corrosion had progressed to such an extent as to cause some doubts as to the vessel's seaworthiness in all conditions, and a board of survey was ordered. The board reported the vessel as being, in its opinion, quite seaworthy, but found that the corrosion of framing in boiler- and engine-room spaces had proceeded to a serious extent. They recommended the renewal in boiler and engine rooms of floors, reverse bars, longitudinals, rider plates, fore and aft angles, and parts of boiler saddles, foundations for pump machinery, and tops of fresh-water tanks.

These repairs involved the renewal of boiler saddles and consequently either shoring the boilers up from the bottom of the dry dock, shifting them around so as to leave a clear space for the work, or their removal from the ship. The first plan of lifting the boilers and supporting them from the bottom of the dock was considered and it was found that, due to the structure as shown on the sectional view (Fig. 2), it was not possible to raise them more than 18 in., and this would not give sufficient space to permit the riveters, etc., to work to best advantage. Then consideration was given to shifting the boilers around, which could be accomplished by cutting away the bulkhead, separating the bunker space from the boiler rooms. This method was decided upon until it was found that repairs were required on the boilers themselves; then although their removal from the ship required considerable structural work, it was decided to do it.

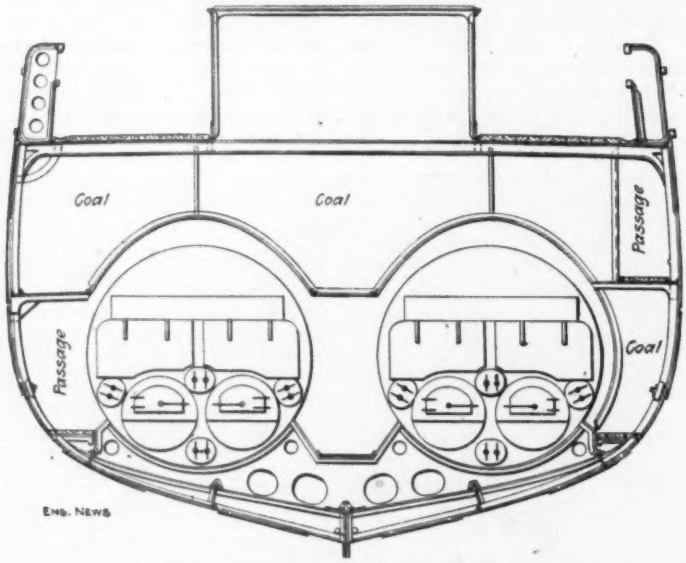


FIG. 2. SECTIONAL VIEW, U. S. S. "DOLPHIN"
(Showing construction in boiler spaces and inaccessible places especially on starboard side.)

The question arose as to whether the outside shell plating of the ship had not suffered to such an extent as to render renewal necessary. With this in mind holes were drilled through in a number of places where it appeared from sounding or from evidence of corrosion that the metal had suffered. The minimum thickness of steel found was $\frac{3}{8}$ in., which is amply sufficient for a vessel of this size so, strangely enough to many, no renewal of outside plating is necessary.

The Death Rate of the District of Columbia for the year 1911, was 17.8 per 1000. This was the lowest death rate ever recorded for the District. The rate for the white population was only 14.61 as against 26.12 for the colored population.

Concrete Construction of the Watertown Plank Road, Wisconsin

BY H. J. KUELLING*

The Watertown Plank Road extends from the western city limits of Milwaukee, Wis., to the city of Wauwatosa, a distance of 8300 ft. The first 2000 ft. of this distance is down a long hill with almost a uniform grade of 4½%. The remainder of the road follows a more easy grade, varying from 0.5 to 1.5%. The alignment of the road is more or less crooked, due to the fact that the road follows along the base of the hill down which its first stretch of 2000 ft. extends. The road is one of the oldest and has the heaviest traffic of any road leading into the city. Along it are situated two large breweries, two stone quarries and a brick yard, besides several other minor industries, all of which send heavy loads into the city. In addition to this regular heavy traffic, there is a considerable amount of mixed traffic from outlying districts.

It was decided to build the first 2000 ft. of this road with sandstone-block paving on a 6-in. concrete foundation and a 2-in. sand cushion, with a total width for the pavement of 24 ft. The remaining 6300 ft. is of one-course concrete (of 1:2:4 mixture), 18 ft. wide, having a thickness of 8 in. in the center and 6 in. on the sides. This gives the road a flat subgrade, as the crown is 2 in. in a width of 9 ft. The arrangement is shown in Fig. 1, although this represents a concrete pavement only 15 ft. wide, on the Mukwanago Road.

The contract for the construction of the Watertown Plank Road was awarded to the J. Rasmussen & Sons Co., of Oshkosh, Wis., at the following prices:

1. Grading previous to placing the concrete, 49c. per cu.yd. This item was relatively small because the road had been well graded by the town authorities from time to time. The final estimates of grading have not been made as yet, but will probably run between 1500 and 2000 cu.yd., most of which consisted of tearing up the old macadam and gravel roadbed.

2. Placing the 12,600 sq.yd. of concrete paving, 40c. per sq.yd.

3. Constructing 5333 sq.yd. of sandstone-block pavement, 80c. per sq.yd.

All materials were furnished to the contractor, the water and cement being furnished on the job. The remainder of the materials, consisting of stone, gravel, sandstone blocks, steel and asphaltic felt for the expansion joints, were furnished at the nearest railway switch track. Later an agreement was reached whereby the stone and gravel were hauled in from local quarries and pits, the contractor to

*Civil Engineer, County Highway Commissioner, Milwaukee, Wis.

pay 7½c. per sq.yd. of pavement for hauling the same. Most of the gravel cost 90c. per cu.yd., delivered on the job, while the crushed stone cost $1 per cu.yd. delivered. The sandstone blocks cost 7c. per block, plus the freight, which was 4c. per 100 lb. About 23 of these blocks

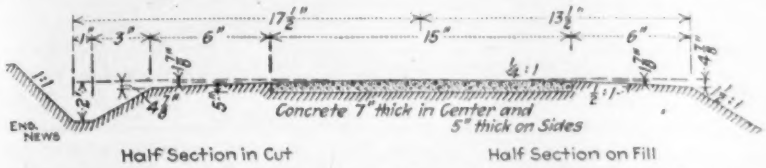


FIG. 1. CROSS-SECTION OF HIGHWAY WITH 15-FT. CONCRETE PAVEMENT; MUKWANAGO ROAD, MILWAUKEE COUNTY HIGHWAY DEPARTMENT, WISCONSIN

(H. J. Kuelling, County Highway Commissioner, Milwaukee, Wis.)

were required per sq.yd. The asphaltic felt for the expansion joints cost $55 per ton, and the steel $4.50 per mile (with the joints placed 25 ft. apart). These prices brought the cost of each joint to about $2.75. The water was piped in 2-in. galvanized-iron pipes from city hydrants to the mixer, the water being paid for at 1¼c. per cu.yd. of concrete placed. The cement was delivered on the job at $1.04 per bbl.

Work progressed at the rate of about 300 lin.ft. of concrete per day, the same crew, however, being used to prepare subgrade and do grading as well as to place the concrete. The average crew was made up as follows:

1 foreman.
1 man who assembled the expansion joints of steel and felt ready to be placed in the road.
3 men who trimmed up the subgrade so the material could be dumped and the concrete placed.
2 form setters who easily handled the specially made steel and wooden forms, which are held in place by iron pins running through the forms.
6 men who shoveled into wheelbarrows.
4 men who handled the wheelbarrows.
2 men for handling cement (one who delivered it and one who dumped the cement into the hopper).
1 engineman on the mixer, which was a Foote batch mixer with a short delivery spout. On this job the engineman also ran the hoists.
1 fireman at the mixer.
1 man who handled the spout for placing the concrete on the road.
2 men who struck off the concrete with a strike-board cut to the crown of the road.
1 man who finished the concrete and trimmed the edges. The trimming was done from a bridge which rested on the forms.
1 man who helped at various jobs.

This made a total of 25 men, whose pay amounted to about $63 per day. This crew averaged about 300 lin.ft. per day when working.

The total cost of the sandstone section was about $2.85 per sq.yd., while the cost of the concrete was about 95c. per sq.yd., both exclusive of grading which averaged about 5c. per sq.yd. for the entire job.

The cost of the concrete section is made up about as follows:

	Cents.
Hauling materials and mixing and placing same	40.0
Cement	33.0
Stone and gravel	15.0
Joints	5.5
Inspection and furnishing water	1.5
Total, per sq. yd.	95.0

The expansion joints are erected separately by one man who fastens two pieces of felt and two pieces of steel together with small clips. This leaves the whole joint ready to be placed in the road when the concrete outfit is ready for it. This joint is a patented contrivance,* consisting of two steel plates on edge, with

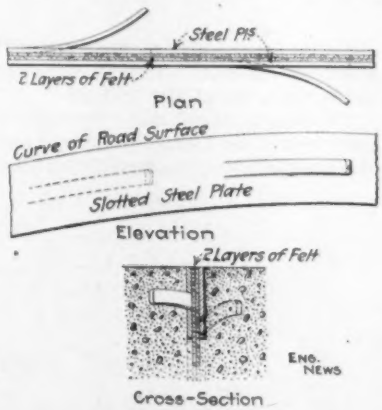


FIG. 2. EXPANSION JOINT IN CONCRETE ROAD

(Not to scale.)

two layers of felt between them, as shown in Fig. 2. The plates are $\frac{3}{16}$ in. thick and 2½ in. deep, and are punched or slotted at the middle to form projecting wings or lugs about 5 in. long. These wings serve to anchor the metal in the concrete. The felt is an asphaltic felt, furnished in the width desired, which in this particular instance was 7 in.; it is done up in rolls of about 35 lb. in weight. The width of the expansion joint is two thicknesses of ⅛ in. felt.

*The R. D. Baker Co., Detroit, Mich.

For the concrete on most of the work we had one part of crushed stone (from ¾ to 1½ in. size) to two parts of pit gravel. However, I do not consider this a good plan, as it would be safer to separate the sand and stone in the gravel before adding additional stone to it. Some of the stone in the gravel ran as high as 2 and 2½ in. in size.

The concrete was mixed quite wet and therefore received very little tamping. The surface of the concrete, after being struck off to the form of the road, was finished from a bridge by means of a hand float, after which the surface was lightly broomed. The steel forms were channels which had holes bored through the flanges through which iron pins were passed, thus holding the channel in any position desired. The wooden forms were held in line by pins and strips of metal which extended between the 2x6-in. sticks and overlapped.

During construction, the traffic was sent around on side roads, of which there were a considerable number entering into the road being constructed. Where this was impossible, some of it was cared for by sending it along the sidewalk space.

Gatun Lake. on the Panama Canal, now covers an area of about 100 sq.miles, with its surface at an elevation of 50 ft. above sea level. When the lake is raised to its permanent level of 87 ft. above sea level, its area will be 167.4 sq. miles. The interesting sanitary condition of the lake is described as follows in the "Canal Record" of Nov. 27:

In its spread the lake inundates a territory covered with timber or dense vegetation or swamp. The vegetation has been decaying, and the stagnant backwaters are dark and tainted with the various odors of putrefaction. In some instances the water has become so exhausted of oxygen as to kill quantities of fish, the decaying bodies of which add to the taint.

At the spillway of Gatun Dam, where the water is passing over the uncompleted portion of the ogee, at elevation + 50 ft., it has a strong and repulsive smell, mostly of hydrogen sulphide. This sulphide is present to such extent that, liberated from the spray in gaseous form, it attacks the paint on nearby ironwork and buildings. A stiff breeze across the spillway toward Gatun will make the fumes perceptible in the village, as much as a mile away.

The lower strata of water in the lake, as in lakes in temperate countries, become exhausted of dissolved oxygen. The living organisms, plants and animals, use some of it in respiration, but by far the most is consumed in the decomposition of organic matter. The amount and rate of exhaustion of dissolved oxygen at the bottom of a lake depend on the quantity of organic matter, the temperature of the water and the volume of water below the thermocline. All three of these factors are present in Gatun Lake to a relatively high degree.

But under the normal flow at locks and spillway, when the Canal is in operation, and with the supply of fresh water from the Chagres and other streams tributary to the lake, the surface stratum will be less objectionable.

Water from Gatun Lake is to be used for an auxiliary potable supply to Cristobal and Colon. A tunnel is being driven through the ridge between the lake and the Atlantic water-shed and a 20-in. pipe will be laid through the tunnel. Provision has been made for aëration and filtration of the supply from Gatun Lake, and its use will be only necessary when the regular supply from Brazos Brook is insufficient.

The 523½ Ft. Steel Arch Bridge over the Sanaga River, Cameroon, South Africa

By K. A. Muellenhoff*

A steel-arch bridge, ranking with the notable structures of that type in the world, has recently been completed in Africa, in the German colony of Cameroon, which lies near the equator bordering on the Gulf of Guinea. The bridge crosses the River Sanaga near the town of Edea, and has the longest span of

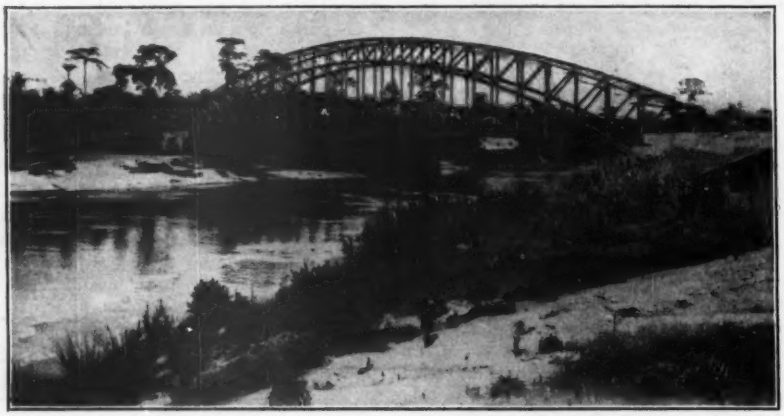
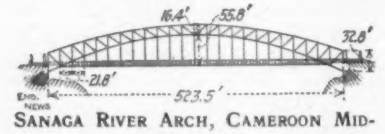


Fig. 1. Edea Falls Bridge over Sanaga River, Cameroon Midland Ry. An Arch Span of 523½ Ft.

any bridge in the Dark Continent, a distinction held hitherto by the Zambesi Bridge at Victoria Falls. Like the latter, the Sanaga Bridge crosses a great river immediately below one of the cataracts which are characteristic of the large

Zambesi River Arch, Cape-to-Cairo Ry.



Sanaga River Arch, Cameroon Midland Ry.

Fig. 2. Comparison Sketch of Zambesi and Sanaga Arches

African rivers. Both bridges have about the same length, and both carry a single-track railway line.

The Zambesi flows in a deep, narrow gorge and the track on the bridge is about 400 ft. above the water. The Sanaga, on the contrary, flows through a comparatively level country, and the rail level is only about 25 ft. above the high-water level. This is the reason for the adoption of an entirely different arrangement of trusses in the two bridges.

Table I. Comparison between the Bridges over the Zambesi and Sanaga Rivers

	Zambesi	Sanaga
Span between centers of hinges	500 ft.	523 ft. 7½ in.
Rise of lower chord	90 ft.	65 ft. 7½ in.
Height of truss at center	15 ft.	16 ft. 4½ in.
Height of truss at hinges	105 ft.	32 ft. 9½ in.
Panel length	25 ft.	21 ft. 9½ in.
Clear width of roadway	30 ft.	26 ft. 3 in.
Distance apart of trusses at top	27 ft. 6 in.	27 ft. 10½ in.
Distance apart of trusses at hinges	53 ft. 9 in.	
Total weight of steel work	1650 tons	900 tons

The bridges are alike in being true arches, as the Sanaga Bridge, in spite of its appearance, has no tie-member to relieve the abutments of the horizontal thrust of the arch. Table I gives the main dimensions of both bridges.

The Sanaga Bridge spans the main or south arm of the Sanaga River, and carries the Cameroon Midland Ry., a narrow-gage line built by the Imperial German Government for the development of the country. Fig. 3 is a map of the line. Starting from Duala, the seat of the government, it passes first through low-lying swampy country with tropical climate; the ascent to the elevated interior begins at Edea, where the Sanaga River is crossed.

The river at this point is divided into two arms. The northern is comparatively shallow; it is crossed by a series of 150-ft. truss spans. The southern or main

Fig. 3. Map of Cameroon, Showing New Midland Ry. and Location of Sanaga Crossing

arm of the river is about 60 ft. deep at low water, with a bottom of very hard gneiss rock covered at the southern bank only by a deposit of sand and gravel. It was therefore much more difficult to bridge.

The difficulties were increased by the hydraulic conditions. The cross-section of the river is about 13,000 sq.ft. at low water, and about 23,000 sq.ft. at high water. The highest water occurs regularly in October, while from then to the middle of March the river falls some 20 to 25 ft. The rising is less regular, as is shown by Fig. 4, giving the stages of the river during the years 1908-09-10. The same diagram gives also the monthly precipitation from July, 1910, to June, 1911, at Sakbayene, a place which is situated three marches (about 50 miles) above the site of the bridge. The highest monthly precipitation is about 35 in., and the total rainfall during the twelve months amounted to 103 in. The rainfall is distributed very unevenly over the year; for example November and December have no precipitation at all. During the rainy season the precipitation is enormous. At Malimba, at the mouth of the Sanaga River, 8½ in. fell in one day. As a result, the river may rise abruptly; a rise of 3 ft. in one day has been recorded.

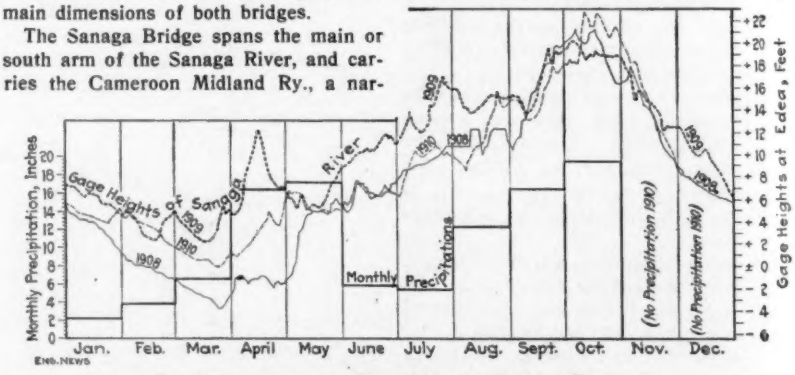


Fig. 4. Rainfall and River Stages, Sanaga River

(River stages 1908-1910; Rainfall July 1910—June 1911, at Sakbayene, three marches or about 50 mi. above the bridge site.)

The current at the site of the bridge is always swift: at low water about 14 ft.

*Engineer in Bridge Department of the Gutehoffnungshütte, Sterkrade, Germany.

per sec., at high water over 40 ft. per sec. As the drainage area is about 55,000 sq.mi. (as much as England without Wales, or as much as New York, Connecticut and Rhode Island combined), it

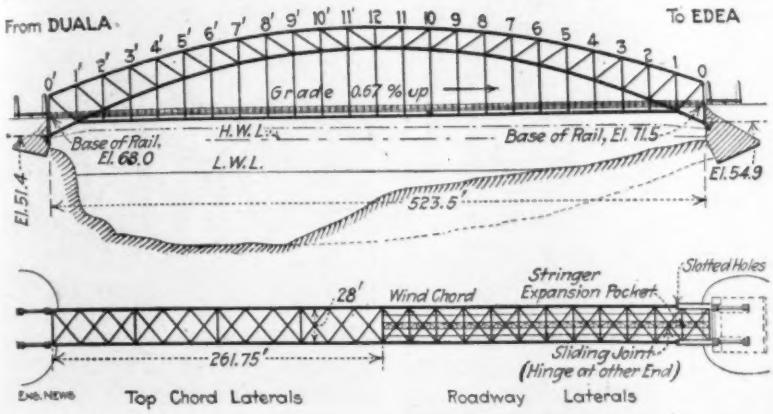


FIG. 5. OUTLINE DRAWING OF SANAGA RIVER BRIDGE

can be imagined that the quantity of water passing during a flood is enormous. The deposit of sand and gravel at the southern bank, already mentioned, shown by dotted line in Fig. 5, varies considerably in size and shape as a result of these flood conditions.

All these circumstances dictated a single-span crossing over the south arm, and moreover a span of a type permitting erection without falsework, at least in the right half of the channel.

DESIGN OF THE SANAGA BRIDGE

As the gneiss rock afforded excellent foundation for abutments, an arch bridge was adopted, of the outline shown in Fig. 5. The arch has end hinges only, but it was erected as a three-hinged arch, the closing members at the center being riveted in place only after nearly the entire dead-load was on. This arrangement has the advantage that slight inaccuracies in locating the abutments do not affect the stresses in the bridge, and it also facilitates the erection.

The bridge was designed for a railway live-load as fixed by the specifications for bridges of the colonial railways of the German Empire: two locomotives of 55 tons each (five axles, 11,000 lb. on each wheel, axles spaced 47 in. c. to c., length of locomotive 27.5 ft. over all) followed by 23.6-ft. cars of 35.2 tons (two four-wheel trucks, 8800 lb. per wheel, truck wheelbase 47 in., trucks 11.8 ft. c. to c.; front wheel of car 9 ft. 10 in. behind rear driver). For the stringers and floorbeams, the axle-load is higher: 4 axles of 12.1 tons each, or 3 of 13.2 tons, or 2 of 14.3 tons.

The floorbeams are proportioned in addition for a wooden roadway, and teams of 22 tons weight, but the roadway stringers have been omitted, as there is no wagon road in the country near the bridge. On one side a footwalk has been provided, with a loading of 82 lb. per sq.ft.; a similar walk can be built later on the other side.

The wind load was taken as 51.2 lb. per sq.ft. exposed area of the bridge unloaded, and 30.7 per sq.ft. bridge and 10 ft. height of live-load for the loaded bridge. The full area of the windward truss and half the area of the leeward truss are counted. The bridge is required to have a factor of safety of 1.5 against overturning, both when empty and when covered with empty box-cars, the weight of which is taken as 672 lb. per lin.ft.

On the first axle, a horizontal transverse force of 4.4 tons is assumed. No impact is allowed for.

For computing braking stresses the coefficient of friction is taken as $\frac{1}{7}$, all the locomotives and one-third of all car axles being considered braked. A temperature range from 50° to 160° F. was assumed.

The permissible unit-stresses are:

	lb. per sq.in.
Main trusses and bracing without wind	15,000
with wind	17,000
Rivets, shear	13,500
bearing	27,000
Floor members	10,666
Rivets in floor, shear	9,950
bearing	19,000
Cast-steel in bearing, compression	21,300
tension	17,100

All members in compression must have a minimum factor of safety of 5 against buckling, after Euler's formula.

Sections of typical members of the bridge are shown in Fig. 6, which gives also the detail of the center connection. The floor construction may be seen from the cross-section, Fig. 9. The general nature of the framing is further exhibited by the view Fig. 8 of the south end. Here may be seen the plate-girder portal, and the latticed top-laterals, with tapered ends for connection to a single lateral place.

There is a complete lateral system in the top chord, from portal to portal, and another in the plane of the roadway between panel-points 1 and 1', extending thence down to the end shoes in the plane of the bottom chord. Except in the end panels, the bottom chord has no lateral bracing, but is held by sway-frames at every third panel-point, and further by the stiffness of the vertical truss-members and hangers between upper and lower lateral systems.

The lower lateral truss, not being in the line of the bottom chord, required a separate wind chord (see Fig. 7). To prevent any arch tension in this chord, it is attached at panel-points 1 and 1', where it meets the arch chord, by bolts in slotted holes. This point is also made

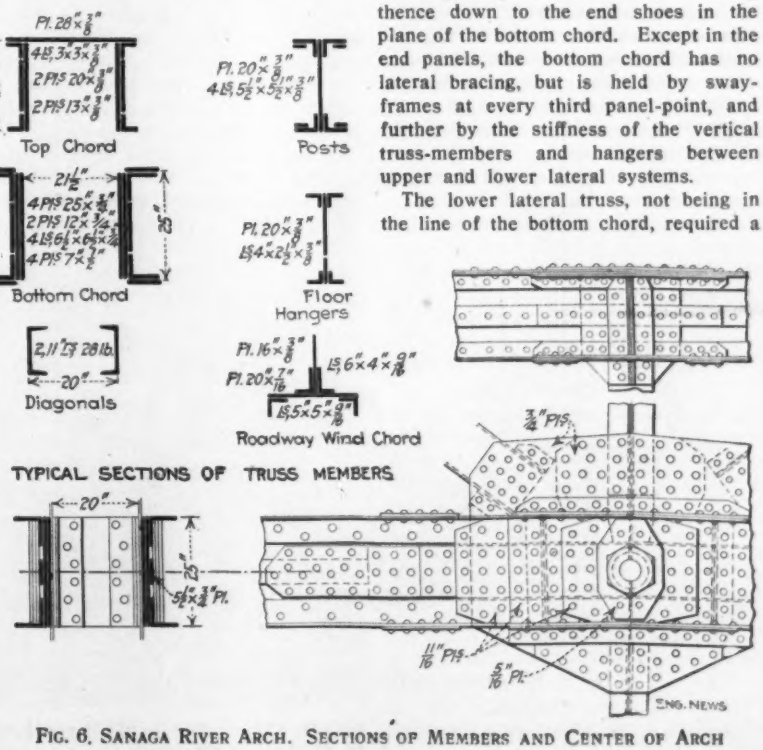


FIG. 6. SANAGA RIVER ARCH. SECTIONS OF MEMBERS AND CENTER OF ARCH

the expansion joint of the floor and lower lateral system for temperature and arch effects. The stringers of the floor are seated in pockets attached to floorbeam 1, and can slide in these pockets. The laterals have a sliding joint at the central point of panel 1-2, and the lateral panel 0-1 acts as a cantilever. This joint and the wind-chord joint are shown in Fig. 9. At the corresponding panel-point of the other end of the bridge the connections of the stringers and wind chord are riveted so as to be able to transmit braking stresses, and the joint in the lateral diagonal system is a pin joint. The top-lateral system has diagonals only, transverse struts being introduced only at every third panel-point, where the sway-frames occur.

The central hinge in the lower chord and the riveted connection subsequently made in the upper chord are shown in Fig. 6. The hinge pin is 6⅞ in. in diameter. The chord is heavily reinforced by pin-plates. The gusset plates are cut at the center line. When the middle vertical and the two adjoining top-chord members were later put in, the splice-plates and angles were placed and riveted.

In Fig. 7 is shown a suspended beam attached to the truss vertical below the top chord. This occurs at every panel-point, and has the object of carrying a footwalk for inspection and maintenance, specially important in this moist tropical climate and just below a large waterfall, where the spray of the falls occasionally reaches even to the bridge. A similar footwalk bracket is provided on the outside of the posts. For inspecting and painting the floor an inspection crane track is attached outside of the floor, as shown in Fig. 7; a carriage extending under the floor runs on this track. Having regard to the moist air and heavy rainfall, great care was taken in the design of the steelwork to avoid all water-pockets and all places which could not be reached by the brush.

The end shoes of the arch consist of cast steel (Fig. 10). They are placed normal to the line of maximum thrust, i.e., with base inclined about 60° to the horizontal. They are provided with long wedges for adjustment after the closing of the arch. They rest on relatively small abutments of concrete reinforced by a grillage of heavy 19x12-in. I-beams of the Grey type imbedded in the concrete.

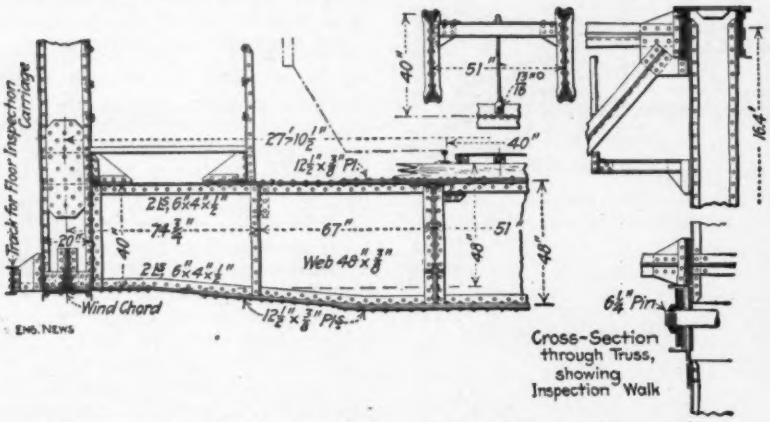


FIG. 7. CROSS-SECTION OF SANAGA BRIDGE, AND TOP-CHORD INSPECTION WALK

FIG. 8. LEFT END OF SANAGA RIVER BRIDGE, DURING ERECTION, SHOWING FRAMING

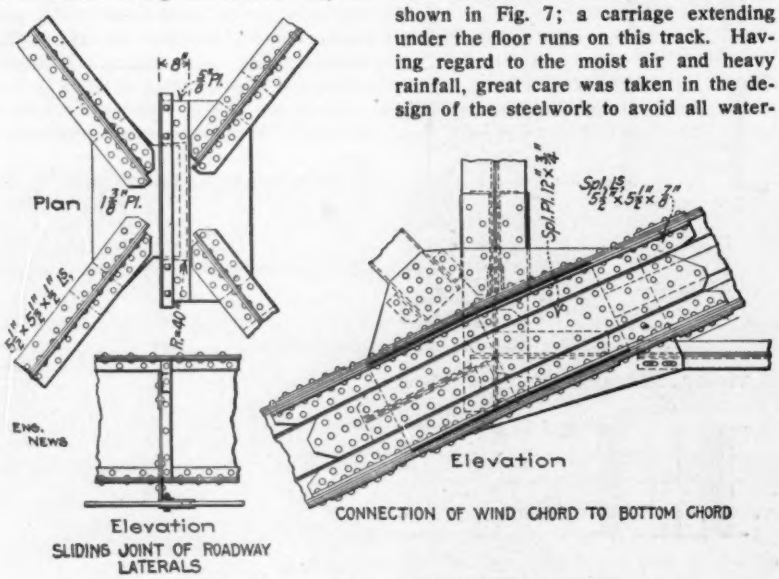


FIG. 9. EXPANSION JOINT OF ROADWAY WIND TRUSS

In the shop, great care was taken to insure complete fitting of every part. As far as possible all like pieces were drilled to the same template (punching was not permitted), and then one-half of a truss was built together completely on skids (Fig. 11) to make sure that there was no error or omission. Also, part of the floor was erected before shipment.

For shipping, no single piece (except the bearings) could weigh more than two tons, as the material had to be shipped from Duala to the site of the bridge through a swampy creek, the Ananga. which is so low at times that it might have been necessary to unload the boats at a place where no cranes were available. For this transport the erection pontoons were used to good advantage. Except for some four miles from the shops to the harbor at Walsum on the Rhine, which belongs to the manufacturing works, the Gutehoffnungshütte, the whole transport was done by water: down the Rhine to Antwerp, from thence to Duala by steamer and then through the Ananga and up the Sanaga by the pontoons to be used later.

Riveting was done in the shop almost exclusively by hydraulic or pneumatic pressure machines or pneumatic hammers, in the field chiefly by pneumatic riveters and hammers. Only a small number of rivets were hand-driven.

Before shipment the steel was painted, after thorough cleaning with wire brushes, with one coat of linseed oil and one coat each of red oxide and zinc oxide. After erection the bridge received two more coats of zinc oxide.

ERECTION

The nature of the river, already described, and the fact that the bridge had

to be erected by unskilled native labor almost exclusively, made the erection a difficult task.

The plan of erecting the bridge on the island and floating it over the river to a stage built on the left bank (sketch *A* in Fig. 12) had to be abandoned on account of the great weight to be handled and the extra metal required in the bridge for erection stresses. Erection from cables hung over the river, or in the manner shown by sketch *B* in Fig. 12, was also out of the question, as the cost was so high. After careful investigation the erection method shown at *C* in Fig. 12 was adopted.

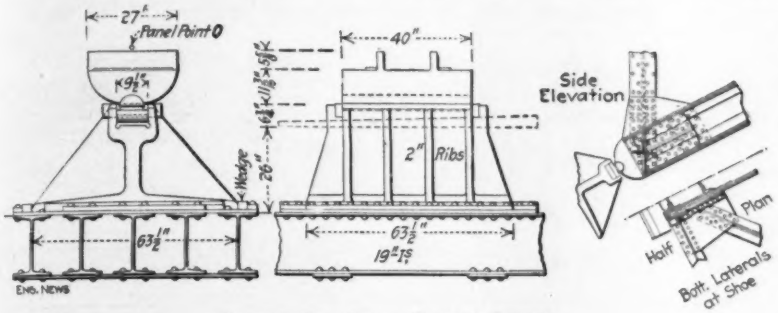


FIG. 10. END SHOE, SANAGA BRIDGE

The left or southern half of the bridge was therefore erected on falsework in the ordinary way up to panel-point 8, and the next four panels of the arch, to the center, were cantilevered, floor and hangers being omitted here. In this stage most of the weight of the bridge rested on panel-point 8; therefore the falsework bent at this point was doubled, wedges being driven to bearing at the next panel-points in order to increase the stability of the bridge. The staging in front of point 8 had to take no load of the bridge and was of comparatively light construction and without material connection to the falsework, because the deposit of sand and gravel was not thought reliable.

Before this half of the bridge was erected, the right or northern half had been erected on the island (see Fig. 13) not on blocking, but on the ground, a pit being made for the depressed end at the portal. It was stiffened (as was the other half also) from panel-point 5 outward by temporary bracing between the hangers. In order to reduce the weight to be moved, the stringers were omitted in panels 9 to 11, and in panel 12 also the floorbeam and hangers.

Two heavy plate-girders were then built between the hangers at panel-points 7 and 8, and under these, directly above the wind chords, two plate-girders about 60 ft. long, which will later be used as a small railway bridge, were placed transversely to the axis of the bridge so that the ends projected some 15 ft. on each side. To the end posts were attached two strong triangular bracket frames, one on each side, as shown in Fig. 17, thoroughly braced to panel-point 1. The whole bridge was then lifted by hydraulic jacks placed under the outer ends of the plate-girders and under the bracket-frames at the portal. Each jack was capable of lifting 200 tons, though the greatest load (on the two jacks in front) was but 125 tons. Simultaneously suitable blocking was placed, and at sufficient height the bridge was seated on this blocking while the blocking used in lifting the bridge was removed from under the plate-girders and portal brackets and replaced by heavy trucks, each capable of carrying a load of 200 tons, running on tracks spaced about 45 ft. apart. These tracks were built with the heaviest longitudinal timbers resting on cross-ties laid close. This track was extended on a concrete wall well in front of the abutment so as to permit the lowering of the bridge to its seat.

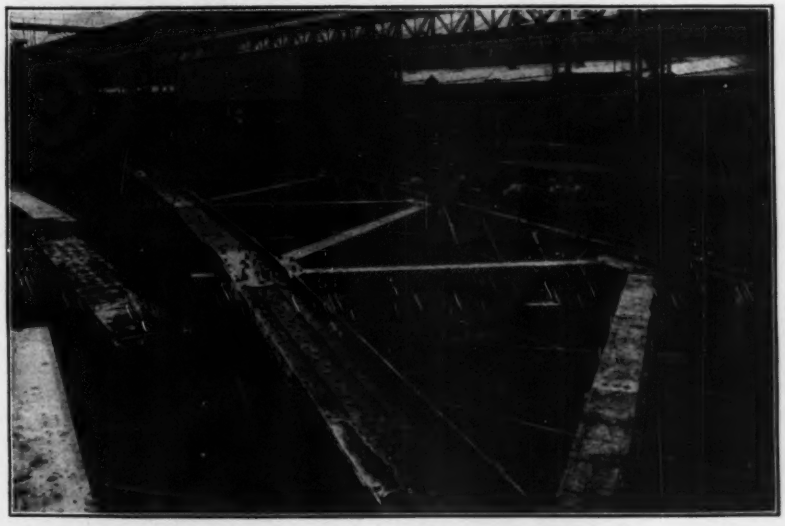


FIG. 11. SANAGA ARCH FITTED AT SHOP

When everything was ready, the bridge was lowered to the trucks, the blocking under the bridge removed and the bridge moved forward until the panels 12 to 10 hung clear over the river and the foremost trucks were standing on the concrete walls in front of the abutment. Then two temporary struts, well braced, were attached to the hangers at points 10 and 11 and the pontoons for floating the bridge over the remaining gap were placed under the bridge.

For this floating, eight steel pontoons of 50 tons capacity each had been provided. These were connected in two groups of four each, on which rested two specially designed trusses about 150 ft. long (see Fig. 15). These trusses are to be used for a railroad bridge elsewhere; they were reinforced where necessary for the present erection service. They had a panel length of exactly one-half the width of the Sanaga Bridge, so that their panel-points fitted exactly under the trusses of the bridge. At these panel-points they were provided with heavy cross-girders which could be bolted to the verticals of the erection trusses at any height required by the stage of the river. The bridge was supported on these girders by means of the struts mentioned above. Bracing was fitted between the erection trusses below the bearing girders; it was arranged to be adjustable and detachable. This bracing was not used, however, as the cross-girders were in fact used in their lowest position. The erection trusses were thoroughly braced, of course.

By pumping out the water ballast from the pontoons, the front of the bridge was then lifted and the trucks under the plate-girders on which it had hitherto rested were removed. The bridge (or rather half-bridge) could now be moved across the river.

Two hand winches were placed on the opposite bank at each side of the left half of the bridge; hauling ropes, 1-in. wire ropes, connected the winches with the trucks under the portal-brackets. Parallel to the hauling ropes were two guide ropes at each end of the pontoons. The pontoons were held against the cur-

rent by the anchorage shown in Fig. 14. The anchor ropes being fitted to winches on the bow of each upstream pontoon, the men at the winches could hold the pontoons always exactly at the guide ropes.

By these appliances the bridge was floated across the river in about two hours' time. When it reached its final position laterally, the jaw of the center

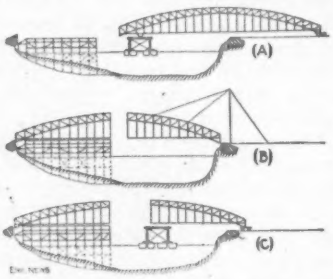


FIG. 12. ALTERNATIVE ERECTION SCHEMES

hinge on the movable half stood somewhat above the jaw on the falsework half of the bridge (Fig. 17). The next day the river had fallen sufficiently to bring the floating half to its proper level, and the center pins were placed, the wedges in the bearings driven home, the pontoons removed, and the wedges under the stiffened hanger on panel point 8 on the falsework taken away. Thus the bridge stood as a three-hinged arch. It was a comparatively easy matter to attach the remaining hangers, complete the floor system, finish the riveting of the bridge, and lay the track. Finally the last two members of the top chord were put into place and riveted up, so that for live-load and temperature changes the bridge acts as a two-hinged arch.

The bridge was designed, fabricated and erected by the Gutehoffnungshütte Aktienverein für Bergbau und Hüttstenbetrieb, in Oberhausen, Germany. Except one resident engineer and a number of white foremen, the whole erection was done by native labor, which was found better than expected, though some delay was experienced from that source.

Much delay was caused by the river, which fell so low when the bridge was ready for moving that it became necessary to wait several months, till after the flood of 1911.

There were also several exciting incidents. For example, when the bridge was being floated across the river, a dead antelope drifted along, and all the blacks with great shouting were about to jump into the river in order to get the precious meat; strong measures were required to hold them back.

That the bridge has been finished without serious mishap and in spite of the most trying conditions, is chiefly due to the resourcefulness of the Resident Engineer, Mr. Kuehne.

Use, Waste and Metering of Water in Chicago

The city of Chicago has an unfavorable prominence in regard to its reckless and enormous waste of water, which represents approximately 50% of the amount pumped. While this waste results in excessive cost of pumpage and operation of the water-supply system, it has a still more serious economic result in causing the effective supply to be insufficient. That is to say, in some sections where the waste is largest the pressure is so reduced by this waste that the upper floors of buildings receive little or no water. The net result is that while Chicago has at its doors a vast and wholesome source of supply in Lake Michigan, has an extensive system of intake tunnels, pumping stations and water mains, and pumps an excessive supply into the mains, it does not furnish a supply of water adequate to the needs of all its inhabitants. And it is in the poorer districts, where an abundant supply is most needed, that the deficiency is most evident.

In order to analyze and locate the waste, the Water Department has conducted extensive investigation by a special water-survey division, and the work and results of this survey were described in our issue of May 9, 1912. The matter is discussed by the Commissioner of Public Works in the recently published report for the year 1911, and an abstract of this part of the report is given below. Attention may be called to the reply there made to the stock argument that metering the supply in the poorer districts would lead to an insufficient use of water, and this is an answer to the similar argument attributed to Mayor Gaynor in objecting to the metering of the domestic supply in New York.

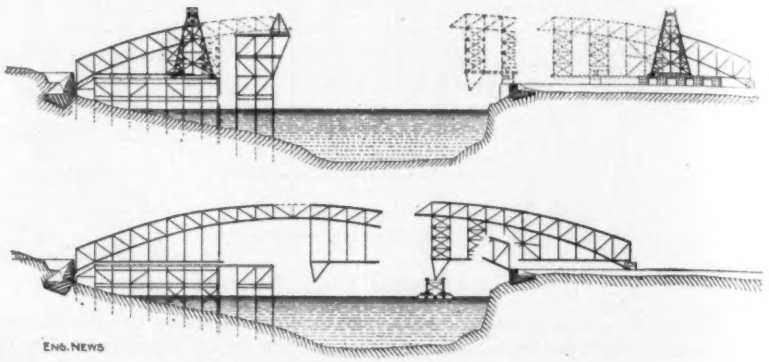


FIG. 13. SUCCESSIVE STAGES OF ERECTION, SANAGA RIVER BRIDGE

WATER CONSUMPTION AND WASTE

The report shows that the average actual daily pumpage of water into the mains throughout 1911 amounted to 431,232,500 gal. The average daily consumption per capita (based upon this pumpage and an estimated population of 2,259,000) was 191 gal. An analysis of what becomes of this great quantity of water, based upon the investigations of the survey division of the Water Department, shows the results which are summarized in the accompanying table. From this it will be seen that about half of the enormous amount of water pumped is

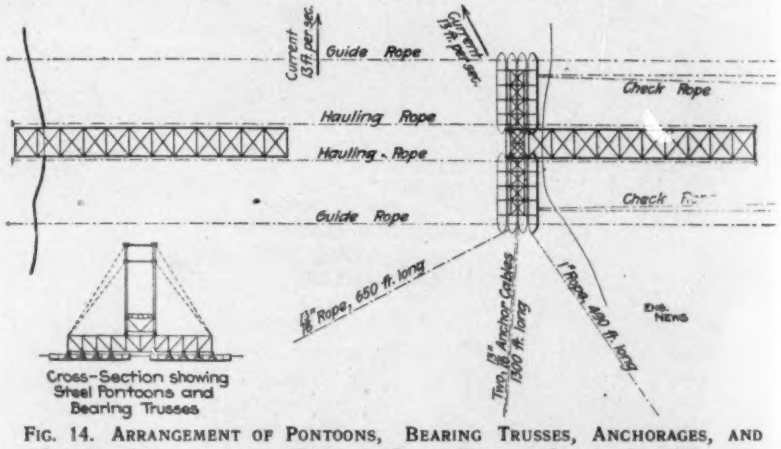


FIG. 14. ARRANGEMENT OF PONTOONS, BEARING TRUSSES, ANCHORAGES, AND HAULING APPLIANCES FOR FLOATING RIGHT HALF OF SANAGA RIVER BRIDGE INTO PLACE

TABLE OF WATER CONSUMPTION AND WASTE IN CHICAGO

	Per cent of total pumpage	Gal. per capita per day
1. Consumed by frontage consumers (household use, laundries, stables, lawns, etc.)	19.5	40
2. Consumed for manufacturing and business (practically all metered, except a large percentage of small stores and saloons)	25.5	45
3. Consumed by public institutions and uses; schools, churches, charitable institutions, (free supply)	5.00	10
4. Waste through defective plumbing	20.0	40
5. Waste by underground leakage and wilful waste	30.0	56
	100.00	191

quantity of water wasted, lost and unaccounted for can be attributed to the following causes: 1, defective plumbing; 2, defective street mains and services; 3, waste to prevent freezing of services and plumbing.

Defective Plumbing

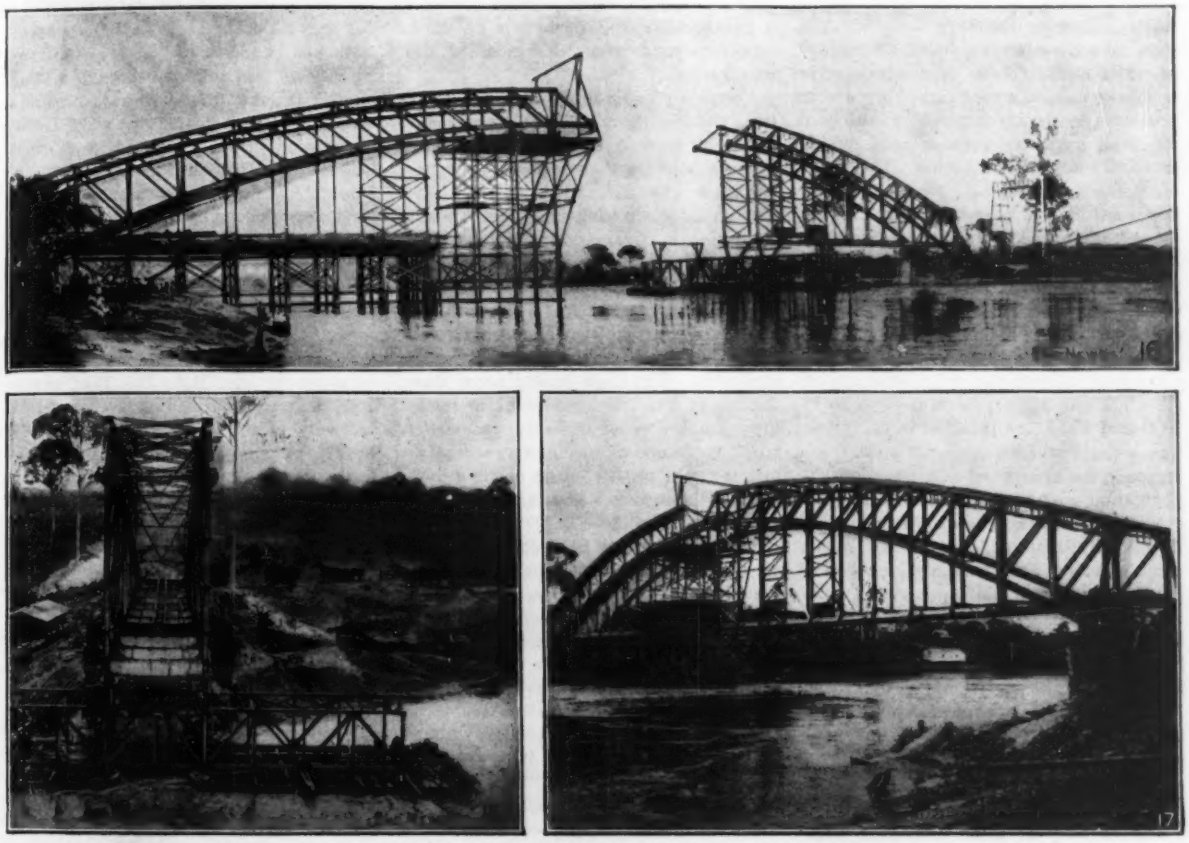
House plumbing is the cause of the waste of a very large percentage of the supply. The general use of modern plumbing conveniences, even in the cheaper classes of houses, has become the custom, and this has resulted in the manufacture and sale of a cheap class of water fixtures, which are the cause of a very large percentage of the waste. The closet tank ball-cock is, without doubt, the source of the greater part of the waste from defective plumbing. This great waste is constant and the water generally flows quietly and unnoticed down the overflow pipe to the sewer; and as it does not increase the water bill, the property owner finds it cheaper to let it run than to call in the plumber.

Waste to Prevent Freezing

While this cause of waste is not continuous throughout the year, it is very large during seasons of extreme cold. Tests during the past winter proved conclusively that from 50 to 100% more water is demanded by the consumer at such times. The greatest demand for supply during cold weather comes from those sections where a cheaper class of plumbing fixtures has been installed. This sudden demand for water produced a condition of low pressures over the city that is most significant. It is conservatively estimated that there are at present over 60,000 hopper closets in the city. Under the schedule of rates for revenue of water, a hopper closet is classified as a water closet, for which the city receives a revenue of $3 or $3.50 per year. It is difficult to convince the willful-waste consumer of the uselessness of continuously open water closets, and in consequence the public suffers from poorer service while the Water Department bears the criticism of such acts.

Metering as a Remedy for Waste

After having studied the conditions of loss and waste even briefly, the Water Department is forced to the conclusion that the one efficient, economical and practical method for lessening the great



Figs. 15 to 17. Floating Right Half of Sanaga Bridge Into Place

(In Fig. 17, the floated half is in position laterally, but is yet a trifle above final level for driving the center hinge pin. After this pin is driven, the arch is three-hinged for dead-load, but it is made two-hinged for live-load and temperature by subsequent closure of the top chord).

simply wasted, this waste being not merely negative, but being positively detrimental to the water-supply service.

The surveys conducted by the Water Department during the past two years show conclusively that there is an enormous consumption of water at night time, or more properly speaking, an enormous quantity of unaccounted for water during the night when the legitimate use of water should be small. In many districts surveyed the consumption during the night time is very little less than during the day period, and during cold weather in some sections it is even greater. The

loss and waste of water in Chicago begins with metering the service. Public sentiment does not appear to be in favor of domestic meters, but undoubtedly this adverse sentiment comes from lack of a full understanding of the benefits to the public welfare and from an exaggerated notion of the inconveniences.

"The object of water meters is not to curtail but to increase the use of water. The restriction of waste not only increases the quantity remaining available for use, but by increasing the pressures throughout the distribution system increases also the utilization of this increased quantity."

One objection sometimes urged against water meters is the fear that they will tend to a harmful restriction of the use of water in the houses of the poor or in tenement blocks, where the owner of the property or his agent would try to save water (if metered) at the expense of his tenants' comfort and health. The reliable answer is found in the test of experience. So far as can be learned from the experience of eight large cities with services practically all metered, no complaint is made that the comfort or health of any class in the community suffers because of the application of water meters.

The report states that water meters in Cleveland reduced the daily consumption from 172 gal. per capita in 1901 to 98 in 1909 and 102 in 1910. This large saving was made notwithstanding a steady increase in the number of services per 1000 population. Other large metered cities report a similar experience. Providence, R. I., fully metered, having as many manufacturing industries per inhabitant as Chicago, has a daily per capita consumption of 40 gal. It is not unreasonable to expect that Chicago through metering could reduce its daily per capita consumption 75 gal., or from 190 to 115 or 125 gal. This alone would raise the pressure over the city about 10 lb. and provide abundant water on third floors.

Future Conditions

The quantity of water consumed during 1911 amounted to 191 gal. daily per capita. The consumption of water per capita needed for the future depends primarily upon the measures taken to prevent waste, abuse and neglect, and to some extent upon the elimination of leakage in the street by the Water Department. Without liberal metering of service pipes no permanent method appears for stopping the waste, abuse and neglect. Unless the preventable waste is reduced, the increase in the water-supply system, while partially serving the purpose of meeting the demands of an increased population and manufacture, will to a greater extent increase the waste and leakage and consequently increase the per capita consumption, without giving any appreciable relief from low pressure.

The Low-Temperature Modification of Bituminous Coals to Form a Smokeless Domestic Fuel*

Early Studies

For several years researches in the low-temperature distillation of bituminous coals have been carried on at the University of Illinois. In the first experiments, it was found that, on heating coal to temperatures of 250° to 500° for periods of less than an hour, the percentages of fixed carbon were increased by more than 25% and there was a corresponding decrease in volatile matter to a point where the formation of smoke was prevented when the modified coal was burned.

Variability was introduced by oxidation; the freshly mined coal on exposure to the air immediately began to give off hydrocarbons and to absorb oxygen. Nitrogen was then used as a suitable medium for heating in non-oxidizing atmospheres. Ordinary commercial nitrogen was found to be contaminated with oxygen, so that later the air in the retort was displaced by steam. This work was done in a retort which was given a rotary motion to equalize temperatures in the coal mass. The coals heated under these conditions were changed so as to render them smokeless in ordinary combustion but, on account of the motion of the retort, the coke product came out in a loose granular state, much like that of the coal before heating.

The work that has been done elsewhere on the modification of such coals has been mostly within the last two or three years. The whole development is small, but the results from different sources are fairly consistent. Nearly all experimenters agree that the heavy smoke-producing benzines and paraffins are given off at low temperatures and are practically eliminated at 500°. It is generally agreed that methane and hydrogen are the principal gas constituents given off above 500°, being decomposition products not only of the coal, but of the gases given off at lower temperatures; below 400°, hydrogen has been found in small amounts. The density and calorific value of the gas varies inversely with the temperature at which it is evolved and a moderate heating of bituminous coal is sufficient to remove enough of the smoke-producing elements to make the combustion of the residue clean and economical.

Very little work has been done in determining the character of the low-temperature tar distillates and an opportunity is presented for investigation here. Paraffin oils, suitable for lubrication and combustion, seem to predominate, while the important aromatic derivitives like anthracene are present to a less extent than in the high-temperature runs.

The earlier investigations of Prof. Parr and Mr. Francis at the University of Illinois* have shown that coal modified at low temperature retains a high calorific value and gains in valuable properties, but that the problem of producing modified coals in marketable condition was not easy of solution.

Recent Work

A more recent study has been completed by Prof. Parr and H. L. Olin on the feasibility of modifying soft coals.

Experimental Study—The apparatus employed is shown in Fig. 1. High-pressure steam was admitted through a 5/8-in. pipe 11 ft. long, fitted with return elbows. The steam was heated by a 26-burner combustion furnace, and led to an 18x8-in. retort containing the coal to be studied. The distillates were piped to a condenser and in turn to a large bottle; oils and tars collected here while gases passed on to a gasometer. A thermocouple, inserted through a stuffing box, measured the temperature of the retort contents. Superheated steam was used for carrying the heat into the coal mass in order to distribute the heat evenly throughout the coal, and obviate the necessity of revolving the container. A battery of gas burners was placed directly under the retort for securing additional heat, and this was retained by means of an asbestos-lined oven which surrounded both retort and furnace.

The coals used were from various counties of Illinois and showed the following range of composition: Moisture, 5 to 9%; ash, 6 to 12%; volatile matter, 35 to 43%; fixed carbon, 39 to 52%; sulphur, 0.8 to 2.9%; B.t.u., 11,400 to 13,600.

A quantity of coal sufficient for one run (2500 to 3000 grams) was crushed at one time. In the first experiments, the particles ranged from 1/4 in. to buckwheat size, the dust being removed by a sieve. At first the coal was put directly into the retort, but it was found that the circulation of steam was too much retarded. To remedy this, a cylindrical sheet-iron container, 6 in. in diameter and perforated with small holes, was used to hold the charge. This allowed a space of about 1 in. all around, and gave the desired free distribution of heat.

Steam was admitted and allowed to blow through the system until the air was entirely displaced. The combustion furnace was then started in the burners under the retort. Coal was not disturbed after heating had begun, except in

*Information and data taken from Bulletin No. 60, University of Illinois, Engineering Experiment Station, "The Coking of Coal at Low Temperatures," by S. W. Parr and H. L. Olin.

*See Bulletin No. 24, University of Illinois, Engineering Experiment Station, "The Modification of Illinois Coal by Low Temperature Distillation," by S. W. Parr and C. K. Francis.

one series where pressure was applied.

The yield of coke under average conditions was approximately 75% to 80%. The coked material obtained varied in character and density somewhat with the kind of coal used and the amount of pressure employed during carbonization.

To determine the reason for greater or less porosity of some coals, or to find conditions for modifying it, the coals were heated under pressure. The sheet-iron container was then replaced by a cast-iron cylinder, 8x4 in., fitted with screw caps. A movable piston was arranged inside and pressed against the charge by tightening nuts on pressure bolts. The cylinder was perforated to allow the escape of gas. (See Fig. 2.) It was found that, to get firm coke, the pressure must be constant.

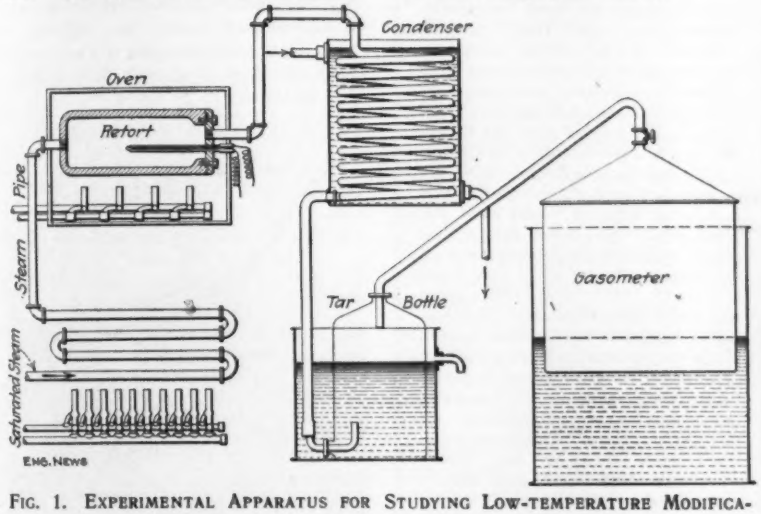


FIG. 1. EXPERIMENTAL APPARATUS FOR STUDYING LOW-TEMPERATURE MODIFICATION OF ILLINOIS COALS

LATEST RESULTS

The investigators report that the friable and non-coking tendencies of the early product has been found to depend directly on the amount of oxidation that occurred in preliminary exposure at ordinary temperatures and in the process of heating at moderate temperatures. It has been found that a dense fuel of good texture can be produced when a careful exclusion of oxygen has been effected, and when there is not enough mechanical disturbance to break up the physical structure. Such fuel would meet the requirements of shipping, storage and industrial use.

The investigators believe that a possible improvement in the manufacture of producer gas is indicated—one which would be free from present difficulties attending the use of bituminous coal. The fuel would be given a preliminary distillation in the retort, and then the modified material would be used in a producer, much as is anthracite.

TAR—The investigation has also shown that the byproducts of the modification process are of value. These comprise illuminating gas and tar. The ammonia water yield is found to be some 0.8 lb. per ton, of coal or about ¼ the usual figure for high-temperature distillation, and possibly not worth recovery. The distribution of products so far as studied seemed to be approximately thus: Tar, 8%; water, 8%; gas, 6.5% (0.46 cu.ft. of 1024-B.t.u. gas per lb. coal); coke, 77.5%. By long distillations, the percentage of coke has been reduced to 72.5 and that of gas raised to 10.9; the gain seems not to have been in the tar.

The general characteristics of the tar were found by fractional distillation of a water-free sample, as follows:

Light oil (30°-100°)	10.5%
Fraction B (100°-200°)	29.1
Fraction C (200°-240°)	29.8
Fraction D (240°-275°)	5.5
Coke residue	21.3
	96.2

It is seen that the tar is composed almost entirely of oils with a minimum amount of pitch and free carbon. Although the yield is greater than with high-temperature distillations, the percentage of pitch and free carbon is much lower—20 instead of 50.

The oils are of peculiar structure and are of more than passing interest, two of the fractions (B and C) being readily oxidizable. The iodine absorption number of the lighter (B) is found to be as high as 165 and that of the heavier (C) from 115 to 125.*

This ready oxidizability is a marked characteristic of drying oils, turpentines, etc., used in paint mixtures. Only a few such general points have been investigated in this connection, but they indicate characteristics of value. The oils are rapidly discolored when exposed to the air, and the lighter fraction yields a dry film on glass at a 45° angle exposed for 24 hr. under the usual standard requirements for such a test. The second fraction has slower drying properties.

*The iodine number expresses the percentage of iodine absorbed and is a chemical test of the oxidizability of the material.

BRIQUETTES—Some of the coals tested showed great plasticity. Determination of the volatile matter of coal, changed to the plastic condition, showed very little reduction in amount. This led to the opinion that fusion existed in the early stages of distillation and soon disappeared. The readiness with which the cementing material ran to waste led to mixing some of the fresh coal with gas-house coke—both crushed to pass a 20-mesh screen. A good solid fuel was secured with up to 75% coke. Mixtures of anthracite and bituminous coal up to 3:1 were firmly cemented together. A press, for keeping the materials in close contact, however, was essential. On account of the known difficulty of such apparatus in a commercial retort, attempts were made to use temporary binders. Mixtures of 3:1 coke and coal were moistened and compressed at pressures of up to 1000 lb. per sq.in. The resultant briquettes were found disintegrated after distillation—owing possibly to the action of escaping steam. When coal tar was substituted, much the same result was obtained, although the briquettes retained their shape. Crude molasses, in amounts above 10% proved best, tests being made with from 5 to 15%. A 3:1 mixture of ground coke residue and Illinois coal, bound with 11% molasses and pressed in a cupel machine, showed after distillation a strength of 550 lb. per sq.in. Similar anthracite briquettes showed 650 lb.; the specific gravity was 1.02, suggesting a practical method of making a better domestic fuel from coke breeze, anthracite waste, etc., than afforded by present coke.

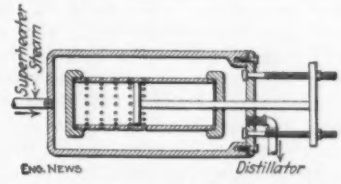


FIG. 2. RETORT FOR HEATING COAL UNDER PRESSURE

THE FORMATION OF COKE—The experiments, taken together with previous study, give additional information on coke formation. Three points are tentatively put forward by the investigators. (1) For the formation of coke there must be present certain bodies which have a rather definite melting point. (2) The temperature of decomposition of these bodies must be above their melting point. (3) If the compounds are not saturated (for oxygen) it is possible to oxidize them, and lower the temperature of decomposition so that they break down before they melt—in which case coking will not occur.

Flood Protection at Kansas City

By Everett B. Murray*

The great flood in the Kaw River in May, 1903, caused such immense damage and property loss in the adjacent towns of Kansas City, Mo., and Kansas City, Kan., that it ranks among the greatest disasters (in regard to property loss) that have occurred in this country. In a distance of four miles no less than sixteen great bridges were carried away. The serious results were largely due to obstructions in and enroachments upon the river channel. Investigation by engineers showed that extensive rectification of the channel was necessary to prevent similar disasters in the future. The flood and the emergency work undertaken to reopen traffic communication and water supply, etc., were described in our issues of Sept. 17 and Oct. 29, 1903, while the flood protection plans and bridge reconstruction work were described in our issue of July 15, 1909. The article given herewith describes the improvement works in the way of levees, bank revetment and bridge alterations. The next, and equally important, work is the clearing out of the bed of the channel. As the obstructions include locomotives, cars, bridges and heavy wreckage of all kinds now deeply embedded in the sand and mud, this work will involve great difficulties.

*Chief Engineer, Kaw Valley Drainage District, Kansas City, Mo.

The Kaw Valley Drainage District* comprises about 7½ sq.mi., or about 5000 acres, the assessed valuation of which (as shown by the assessors' report of 1912) was $47,000,000. It embraces some of the most valuable land in Kansas City, Kan., and though the state line is one of the limits of the district, there is considerable valuable property in Kansas City, Mo., which is also protected. It includes all of the packing companies, innumerable large manufacturing concerns, and considerable railway property.

The amount of damage done during the severe flood of 1903 was estimated at $7,000,000, and it was years before the community which was submerged recovered from the effects of the devastating waters. Even at this present time, with 90% of the protection completed (this is the dikes only, and does not take into consideration the cleaning out of the channel), the lasting effects on the minds of the residents can be seen every year, for when the spring rise comes there are scores of families who move to the higher ground and do not return until all possibilities of high water have passed. It must have been an awful sight to see 19 ft. of water in some of the main streets, and later to see men shovel 2 ft. of mud and sand out of the second floors of their homes and stores.

The district was organized shortly after this flood in June, 1903, and was made legal by an act of legislature in 1905. A board of directors composed of five of the most prominent business men was elected and started work immediately, having the necessary surveys, estimates and reports made, so as to vote bonds for the protective work. This included the construction work necessary to confine the Kansas River by levees, and also the removal of all obstructions in the river which interfered with the free flow of the water, and caused it to be retarded or dammed. This last included the removal of all solid obstructions, such as piling, bridges, etc., which had been washed away by the flood and were in the bed of the river; also the raising and lengthening of all present bridges to the established levee grade so that they might offer no obstruction to the water when it reached flood height. The typical cross-section for the river channel is shown in Fig. 1 (taken between the Kansas Ave. and Belt Line bridges). There was considerable agitation over the required or necessary width of the river. Some maintained that 600 ft. was all that was needed, and some of the packing companies and railways were the promoters of this width. Others, including the Drainage Board, maintained that a 734-ft. channel was necessary. Fortunately, the latter width was adopted (after quite a bitter controversy), for had the narrow channel been voted more than half of the levees would have had to be built either in the river or so close to the water as to make construction practically impossible. This would have meant a failure of the entire scheme, for with the formation of the sub-soil along the river, which is a fine silt saturated with oil and grease, and of a slimy gummy nature, it would have been absolutely impossible to have maintained the embankment built out on it except at an excessive cost, which would have made the work prohibitive. Even as it is, whenever the Harbor Line runs close enough to the water to require construction on this soil, the work practically always develops slides, unless the bank is held by the construction of a pile dike. These slides are caused by the dumped material settling down and squeezing out this soft soil. As soon as the material being dumped strikes a firmer formation, it stops sinking, and there is no more trouble.

Bonds were voted for $1,750,000, of which $1,370,000 were sold. The balance, $380,000, was the amount the engineers estimated would be required to clean out the channel, and it was decided not to sell these until such time as it became necessary to do the work.

Outline of the Work

The task the Drainage Board laid out for itself was divided as follows:

1. The establishing of the harbor lines on each side of the river, 734 ft. apart, and the building of the levees to them. This meant the procuring of the right-of-way from private individuals as well as corporations, after the surveys had been made.

2. The reveting of the levee slopes riverward, so as to prevent high water from cutting the banks and washing them away.

3. The raising and lengthening of all the bridges within the district, so as to meet with the requirements made by the Board. These limited the spans to three, with two piers in the river and the abutments on the harbor lines.

4. The removal of all solid obstructions in the river channel, such as old bridges, piling, waste banks, etc.

The harbor lines were first run by Tuttle & Pike, engineers, of Kansas City, Mo., and were later re-run and checked by the U. S. Government and the engineer for the Drainage Board. These lines extended only from the mouth of the river to the 12th St. bridge, a distance of about 4¼ miles, or about half way. From there to Turner, where the district ends, the lines were established by the engineer for the district. It might be well to add that the river widens out considerably above the 12th St. bridge, and the harbor lines then simply follow the high bank on the most economical location. The levee grade was also

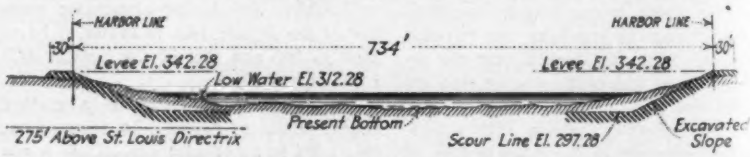


FIG. 1. TYPICAL CROSS-SECTION OF THE KAW RIVER AS RECTIFIED

*President, W. H. Daniels; Secretary, C. C. Craft; offices, Daniels Bldg., Kansas City, Kan.

established by the U. S. government, and the P. B. M.'s set as often as was necessary, not only to check the levels, but to check the points to which the harbor lines were tied, so that they might be re-located at any time, by azimuths, in case the regular Harbor Line points were lost.

Construction

The levees were planned to have an 18-ft. crown or top width above 5th St., and a 30-ft. crown below this point, with a 2 on 1 slope on both sides, the river slope extending down to (or below) standard low water. The levee grade was established 30 ft. above this low-water level, with a fall approximately the same as that of the bed of the river, 0.03% or 1½ ft. to the mile. The entire work was let to one firm of contractors, Callahan Bros., of Omaha, Neb., which sublet

Fig. 2. Building Levees with a Drag-Line or Scraper-Bucket Excavator

different parts to different sub-contractors. The largest of these were the Mun-Reese Construction Co. and the Municipal Contracting Co., and there were several smaller firms. The entire work was divided into sections, varying in length and designated by letters of the alphabet.

The method employed to build the embankment was largely by dragline excavators, with 3-yd. buckets, as in Fig. 2. The material used in making embankment was obtained wholly on the river side of the Harbor Line, and in borrow-pits designated by the engineer. As the general intent was to carry the slope of the levee down to low water (30 ft. below levee grade) it was found that in places there was not enough material excavated opposite the stations to make the fill. In such cases the earth had to be hauled from the nearest available point where there was excess material. Overhaul was paid on everything over 400 ft. (which was the free haul allowed), and

Fig. 3. Building Levees along the Kaw River with Teams and Scrapers

as the sections varied in price this increased the price per cubic yard of some sections considerably. Where possible the machines built the levee to grade as they went along, and also excavated the slope. Part of the work had to be done by teams and scrapers, as shown in Fig. 3; the men in the distance are trimming the grade with shovels.

It may be seen from the above statements that where the fill was light the excavation must necessarily be heavy in order to carry the slope down to low water or for a distance of 60 ft. Where the haul was long, the material was conveyed by means of side-dump cars and small tank locomotives. On some of the sections this overhaul amounted to over half a mile. The specifications were strict in prohibiting the depositing of perishable material of any nature in the embankment. They also prohibited the work proceeding during freezing weather. Where the digging was through good clean material the machine could make about 300 ft. a day on an average fill of 8 ft. All sewers through the levee had to be constructed according to plans approved by the board, and fitted with suitable flood gates.

Revetment Construction

There are four types of revetment used to protect the slope of the embankment from being cut by high water and by débris of different nature carried by the current. They were as follows:

A. Concrete Slab — The concrete slab was 4 in. thick, 8 ft. wide, extending from the top of the embankment down to the toe of the slope. This was reinforced with triangular mesh (No. 9 wire) running the whole length of the slab. At the bottom there were four eyes made of ⅜-in. galvanized cable, twisted to form a loop to which an extension of the protection might be attached at any future time. The concrete was a 1:2:4 mixture. The slabs were poured from a plant at the top of the slope, the mixer emptying into chutes which conveyed the material to the bottom, as shown in Fig. 4. As fast as sufficient material was so placed, a section of the chute about 8 ft. long was taken up, and this process repeated all the way up the slope. A 2-in. layer of concrete was first placed in the above manner and then the reinforcement was laid. Then the chutes were replaced and the remaining 2 in. of concrete placed in a similar manner.

Where the top of the levee came against a retaining-wall of the Kansas City Southern Ry., and was too narrow to admit the mixing plant, the concrete was distributed in side-dump cars, as in Fig. 5. The sand was obtained from vari-

Fig. 4. Building Reinforced-Concrete Slab Revetment on the Kaw River Levees

ous sand plants operating along the river, and though it was too fine for good concrete, it was fairly clean. Chats (or tailings from zinc works) from the Joplin district was used instead of stone, and was found to be a great deal more satisfactory than the latter. Care had to be exercised in wetting the slope during extreme hot weather before the concrete was placed, as well as in wetting the slabs afterward. On some of the sections two cables were run the entire length of the slab and terminated in loops at both ends which projected through the concrete.

FIG. 5. DUMPING CONCRETE FROM CARS FOR REVETMENT WORK

B. RIP-RAP—The second type of revetment was rip-rap, the specifications calling for a hard, durable limestone or sandstone, laid to a depth of 1 ft. and placed perpendicular to a horizontal plane. No stones were allowed that weighed less than 25 lb. or more than 200 lb. After the slope was completed a 4-in. layer of spalls was put over the entire surface. In Fig. 6, the left-hand view shows the body of rip-rap with blocks set vertically; the right-hand view shows the finished slope, filled with spalls. In this latter view the material shown at the right is in the channel and will be removed.

C. CONCRETE BLOCKS—The third type consisted of concrete blocks 24x22½ in. and 4 in. thick. These were reinforced with the wire mesh above mentioned and also with two ¼-in. galvanized-iron rods looped at each end so as to form an eye at opposite ends of the blocks. This type of construction was used at the base of the slab in order to form a flexible concrete mattress to prevent the water from cutting under revetment of either the concrete slab or stone types. These blocks were threaded with ⅜-in. galvanized cable, the ends of which were fastened together with Crosby clips. They were laid in rows, varying in number according to the strength of the current against the bank and the possibilities of its injuring the revetment.

D. BRUSH MATTRESS—The fourth type of revetment consisted of willow mattress 1 ft. thick and varying in width from 40 to 60 ft., as occasion seemed to demand. This was built or woven according to the standard specifications of the U. S. engineers for river improvement work along the Missouri River. This type (like the third) was used only to protect the toe of the main revetment.

FIG. 6. RIP-RAP REVETMENT ON THE KAW RIVER LEVEES

(At the left is the rock revetment, with blocks set vertically. At the right is the finished slope, with stone spalls filled over the rock.)

In the writer's opinion, the first type of revetment (concrete slab) is the best, if the foot of the slope can be protected so as to eliminate the possibilities of undermining. An average day's run for the contractor was about 150 ft. and the sections that had this type progressed a great deal more rapidly toward completion than when the rip-rap was used, not only because of the rapidity with which the revetment could be placed, but because of the ability of the contractor to obtain material a great deal easier than he could obtain rip-rap rock from the quarries. It is true, however, that where rip-rap was used the work could continue as late in the winter as the quarries were open and the men would work, while the concreting naturally ceased as soon as freezing weather set in.

RAISING AND LENGTHENING BRIDGES

The abutments of all the present bridges were within the harbor line, and (with few exceptions) the tops of them were from 2 to 6 ft. below the levee grade. As there were twelve of these bridges to be reconstructed it can readily be seen that a stupendous task was involved. Six of these bridges were owned by railway companies, one by the waterworks company of the two cities, four by the county, and one by the stock-yards company. Work will be started and completed on some of these structures and work will be started within the next month or so on the others, and carried rapidly to completion. On those that have een lengthened and raised already, the tremendous benefits to be derived from the widening of the channel can be very readily seen. The most novel and intricate work was the reconstruction of the Missouri Pacific Ry. bridge. The spans of this were approximately 200 ft. long; but they were moved sidewise and lengthwise without disconnecting any of the spans.

REMOVAL OF OBSTRUCTIONS FROM THE RIVER CHANNEL

Most of the bridges that were carried away by the flood of 1903 were not removed from the river and there are innumerable other obstructions such as car trucks, locomotives, etc., still reposing where the flood deposited them. These offer an obstruction to the water, as far as a scouring out of the channel is concerned, that it is impossible to overcome. Therefore, before the channel can be expected to be entirely improved and navigable, it is very important that these obstructions should be removed. There are also innumerable clusters of piling as well as old falsework which will have to be removed for the same reason. The waste banks along each side of the river, while forming obstructions, are not serious, as they will wash away in the first high water.

This work of clearing the channel has not been started yet, and it is clearly

evident that for confining the river to its channel and securing the safety of the district, this work is as imperative as the building of the levees. A fleet of specially designed dredge-boats will be necessary for the completion of this work, which is likely to offer many more difficult problems than the building of the levees.

Much credit is due Major E. H. Schulz, U. S. Engineer Corps, Kansas City (and now stationed at New Orleans), for the successful solving of many engineering problems which arose at the time the work was first started, and up to the time when his transfer caused him to sever his connections with the Drainage District, which he was serving in the capacity of Consulting Engineer.

Concrete Dikes and Bank Protection on the Missouri River*

By Edward H. Schulz†

[The first part of this paper is devoted to a description of the various steps of progress in the methods of regulating the Missouri River and is taken largely from a report of a Board of Engineer Officers dated Nov. 10, 1910, H. R. Document No. 46, 62d Congress, 1st Session. These steps range from the old weed protection in its various forms to the standard brush mattresses and timber dikes. The final development is the concrete dike and bank revetment which is described below. The first of these used, at Elwood Bend, above St. Joseph, Mo., was built in 1908, and was described by Maj. Schulz at the time in Engineering News, Feb. 18, 1910, p. 177. A portion of that article is repeated below, in small type, to make the present article complete. — Ed. Eng. News.]

The standard timber pile-dikes built along the Missouri River have an average life of from seven to ten years. Usually the cause of their removal in that time is decay about the water line, but very often floods, erosion, floating ice and drift destroy them before they actually wear out. With the idea that concrete would resist both deteriorating influences of rot and exterior abrasive or destructive action, the Chief of Engineers authorized the construction of the concrete dike, in order to test the value of concrete, in Elwood Bend above St. Joseph, Mo. This was built in 1908, and is believed to be the first concrete dike of its kind in any river improvement.

The proposals called for supervising the work of manufacturing the piles and for furnishing forms and reinforcing materials, the United States to furnish other material and make and drive the piles. All piles were to be cast on the ground and were to be driven by jet and hammer combined. Under this specification bids as low as 80c. per lin.ft. were received. Various methods of casting and driving were considered, but were discarded for reasons connected with the peculiar conditions involved. The number of piles used was so small that any method requiring much apparatus would be prohibitive as to cost.

The following gives the more important details of the dike:

Total length of dike 150 ft., of which 40 ft. was timber nearest the shore, and 110 ft. of concrete piles.

Total piles driven, 36. Total linear feet, 1457.

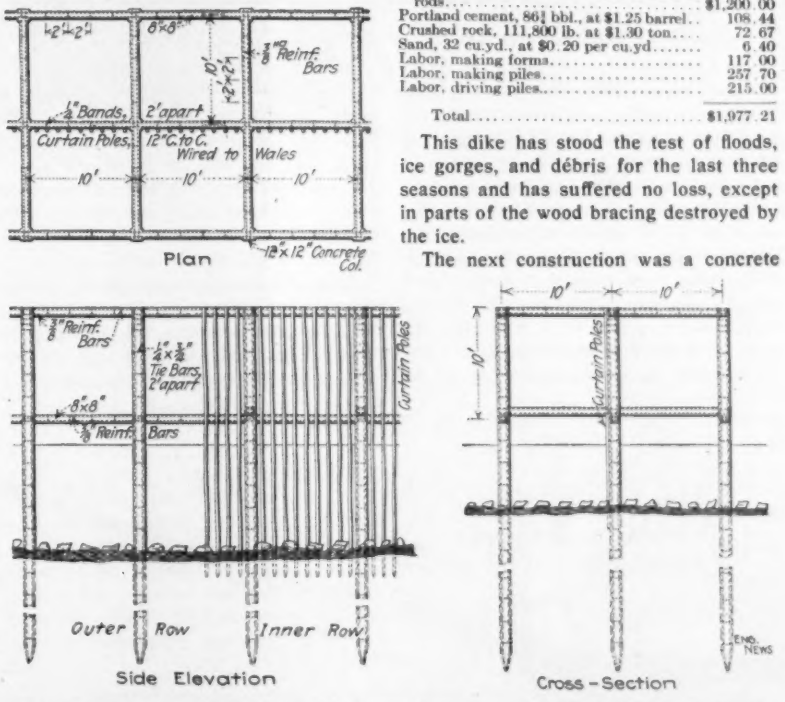


Fig. 1. Details of Three-row Concrete Dike, Pelican Bend, Missouri River

Length of piles, 32 to 50 ft.

Penetration, average, 21 ft.

Elevation of top of piles, 10 ft. above standard low water.

Cross-section of piles: 14 in., square on top, 8 in. square at base.

Reinforcement: Four bars of 1-in. square steel, ½-in. round tie steel, 18 in. c. to c.

Forms, 2-in. yellow pine.

Mixture: 1 part cement, 2 parts Missouri River sand, 4 parts crushed rock, largest size 1 in.

Weight of 50-ft. piles, 8700 lb.

Age, set ten days before driving.

The piles were cast on shore about 6 ft. above a barge, on which they were skidded preparatory to being driven. On account of the weight of the pile, a wire cable, with a single and double block, was used in the handling, slinging each pile at the large end and at about 15 ft. from the small end to take care of the deflection under its own weight. It was found that a pile could bow 5 in. in the 50 ft. without injuring it.

In driving in sand only, the piles were jetted down in about five minutes, by means of a jet attached to a 1¼-in. pipe fastened along the pile. But in that part near the shore covered with rock and débris, considerable difficulty was experienced and the hammer had to be used. At first it was intended to build the piles only of concrete, tying them together with timber, but in a portion of the dike concrete cross beams were substituted for the timber.

The actual cost to the United States was $1.36 per lin.ft. of pile, which, after deducting the expense of special supervision, would make the cost about $1 per lin.ft., a figure which could be expected to be reached by the government in future work. The itemized cost of the construction is as follows:

Invoice for supervising, forms and steel rods	$1,200.00
Portland cement, 861 bbl., at $1.25 barrel	108.44
Crushed rock, 111,800 lb. at $1.30 ton	72.67
Sand, 32 cu.yd., at $0.20 per cu.yd	6.40
Labor, making forms	117.00
Labor, making piles	257.70
Labor, driving piles	215.00
Total	$1,977.21

This dike has stood the test of floods, ice gorges, and débris for the last three seasons and has suffered no loss, except in parts of the wood bracing destroyed by the ice.

The next construction was a concrete dike closing off the left-hand chute of the Republican River above the Washington St. bridge at Fort Riley, Kan. (Fig. 4). The river above the bridge had considerably eroded the left bank, and continued to such an extent that not only was the bridge threatened but also a portion of the U. S. Military Reservation, amounting to about 20 acres. The normal width of the Republican River is from 400 to 600 ft. The shore length to be protected was about 3600 ft., and to revet this entire line would have cost approximately $25,000. Such work would hold the present left bank, but would not materially assist in regulating the river or placing it in its old position.

It was therefore considered advisable to construct two dikes, one closing the left chute, 800 ft. long, extending from

*Portion of a paper entitled "The Development of Regulation Works and the Use of Concrete in the Improvement of the Missouri River," in "Professional Memoirs, Corps of Engineers, U. S. Army and Engineer Department at Large," Nov.-Dec., 1912.

†Major, Corps of Engineers, U. S. A. Recently in charge of the improvement of the Missouri River and its tributaries. New Orleans, La.

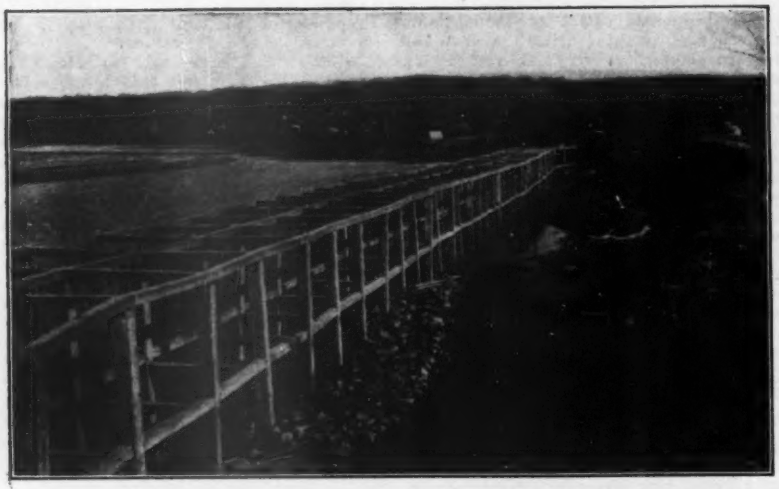


FIG. 2. CONCRETE DIKE, 500 FT. LONG, BONTON BEND, MISSOURI RIVER

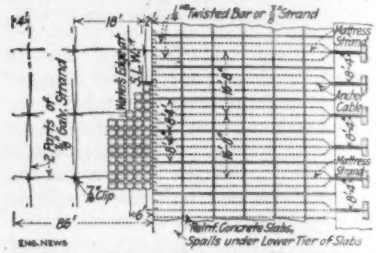
the main bank to the head of the island. This would not only close the chute, but cause the sand bar behind the island to fill in. The other dike, 400 ft. long, was to extend from the foot of the island toward the north end of the bridge, the effect of which would be to deflect the channel to the middle spans of the bridge.

The dike work is similar to that used near St. Joseph on the Missouri River, except that two-row work was used instead of three-row work, and the width of the foot mattress reduced to 40 ft. The estimate for 1200 lin.ft. of two-row dike of yellow-pine piles and braces, with four buttress stay dikes and foot mattress, was $10,000, or $8.33 per lin.ft. The estimate for 1200 lin.ft. of two-row dike of concrete piles and braces with foot mattress, but without stay dikes, was $15,000, or $12.50 per lin.ft.

From the experience previously gained there appeared certain advantages as to durability and strength not belonging to timber dikes, and as the locality at Fort Riley was well suited for the purpose, a concrete dike was approved by the Chief of Engineers.

Two types of concrete piles were considered: One known as the rolled pile and the other an approximately rectangular pile, molded with steel reinforcement. The rolled pile could be furnished for about $1 per lin.ft. of pile, but all the machines were in operation and the company could not do the work before spring. The rectangular cast piles were, therefore, adopted, as they could easily be made by hired labor, and the concrete bracing and foot mattress would in either case have to be done by the United States.

The piles were approximately 11 in. square and 30 ft. long, with an 8-in. point, reinforced with four steel bars of ¾ in. diameter, with steel bands ½ in. diameter, spaced 24 in. centers. The braces were 8x8 in. and were cast in forms built in place. They were reinforced with four steel bars of ⅜ in. diameter. The pile driving was done by



SMALL SCALE PLAN OF MATTRESS

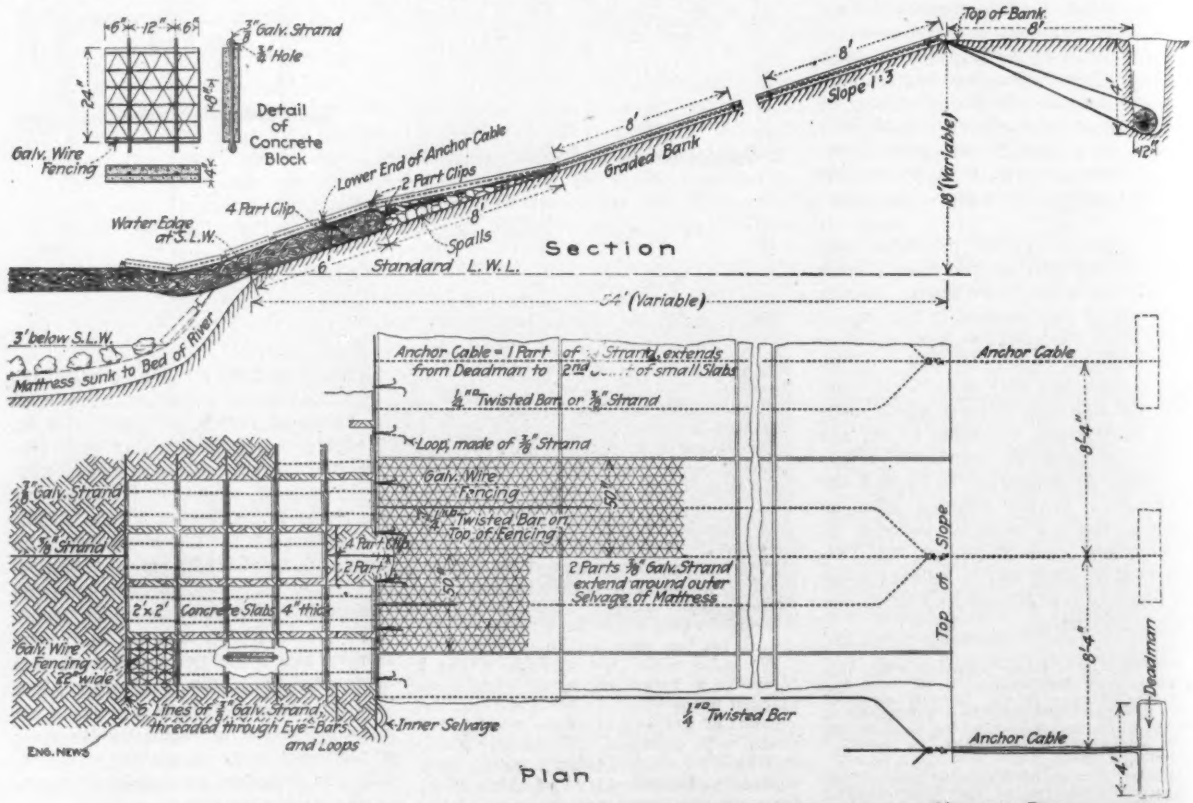


FIG. 3. COMBINATION CONCRETE AND WILLOW MATTRESS REVETMENT USED ON THE MISSOURI RIVER

FIG. 4. LOWER END OF THE UPPER CONCRETE DIKE, FORT RILEY, KANSAS

contract at a price of 31½c. per lin.ft. of pile. Pile driving began Dec. 10, 1909, and was done by a combination hammer and jet. Work was suspended during the winter and was completed Apr. 21, 1910. The pile driving was not prosecuted to the best advantage, owing to the isolated locality, lack of suitable appliances, and two floods which made it necessary to remove materials and appliances.

The number of piles driven was 243, and the total linear feet was 6966.25 at 31½c. Total cost of driving, $2194.37.

The foot mattress for the dike was woven in place ahead of the pile driving. Work began Oct. 18 and was completed Dec. 17, 1909. The cost of the mat was unusually high, due to the freight charges and the long haul by team and the erection of scaffolds for weaving across the water. The screening poles were wired into place on the rear concrete bracing.

The rise of June, 1910, caused no injury to either dike, but damaged the connection with the bank of the upper dike as follows:

At the upper end a 40-ft. break occurred in the brush and rock fill, which was readily repaired. At the lower end a 160-ft. opening between the dike and the head of the island was eroded. The dike itself was not injured. To close this opening and to extend the dike into the island beyond further erosion, an additional construction of 300 lin.ft. was made in the fall of 1911. A 50-ft. mattress was woven ahead of the pile driving across the gap. That for the land dike was also 40 ft. wide and was woven in place after pile driving was completed.

In addition to the willow foot mattress, a system of flexible concrete blocks was laid for 23 ft. at the end of the dike. The blocks are 18 in. square and 4 in. thick, reinforced by four crossed galvanized-iron bars of ¼ in. diameter, with an eye turned on each end to connect adjacent blocks. The eyes are 19 in. centers, and the connection between blocks is made with ¼x1-in. galvanized machine bolt. A total of 300 blocks were cast at a cost of $0.515 per block laid in place. The cost of the original two dikes, 800 and 400 ft., was approximately $11.37 per lin.ft. The cost of the 300-ft. extension (being a smaller job), together with repairs as noted, was approximately $21.80 per lin.ft. The average cost per linear foot of entire 1500 ft. of 2-row concrete dike, with repairs, etc., was approximately $13.03 per lin.ft., comparing favorably in cost with the usual timber pile dike and exceeding it in durability.

In addition to the dike construction, 300 lin.ft. of standard willow revetment was placed above the upper end of the 800-ft. dike, and 100 ft. below the lower end at the head of the island. The mattress was 45 ft. wide and the cost was $6.40 per lin.ft.

The entire system has gone through the recent winter of ice, débris, and flood without any injury.

The third concrete-dike construction was on the left bank of the Missouri River above St. Joseph, Mo. This was built during the season of 1910 to protect an eroded pocket in an original revetment. The dike is 500 ft. long and consists of three rows of concrete piles, spaced 10 ft. c. to c., braced with reinforced-concrete beams, and having the usual foot mattress, pole screen, paving, etc., of the wooden dike. The piles are 12x12 in., reinforced with 1-in. twisted bars tied with ¼-in. round iron every 24 in., and are from 35 to 50 ft. long. The penetration is from 20 to 28 ft., and the tops are about 15 ft. above standard low water. The braces are 8 in. wide, 9 in. deep, and extend from pile to pile (about 9 ft.), and are reinforced with four ¾-in. twisted bars tied with ¼-in. round iron every 24 in.

The willow screening poles were wired to the braces of the center row of piles with No. 12 wire. In casting the piles, holes were left through which the reinforcing bars of the lower braces were placed. The reinforcing bars in the piles were allowed to protrude about 6 in. at the top and the upper-bracing system was built over the tops of the piles, thus bracing the entire structure securely together. One hundred and fifty-three piles, 6564 ft. in all, were cast and mainly driven by jet.

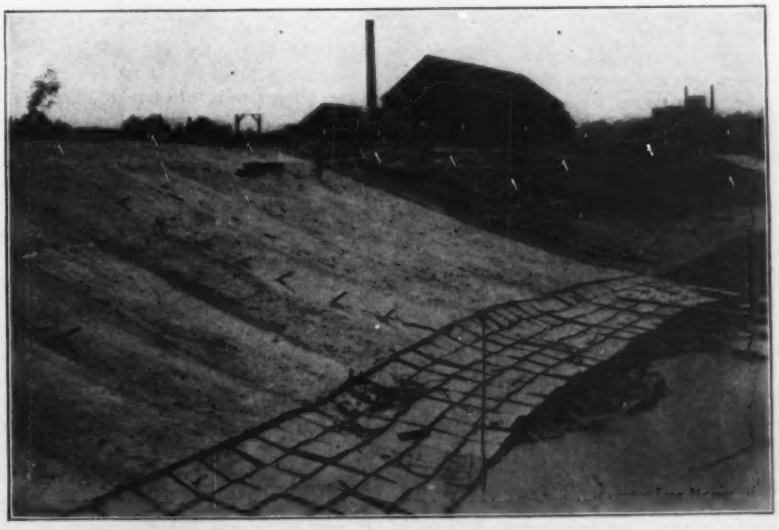


FIG. 5. UPPER END OF THE CONCRETE REVETMENT AT GASCONADE, MO.

SUMMARY OF COST

Casting piles, 6564 lin.ft. at $0.921 per ft.	$6,048.20
Sinking piles, 6396 lin.ft., at $0.545 per ft.	3,489.40
Bracing dike, 4634 lin.ft., at $0.85 per ft.	3,729.60
Weaving and ballasting mattress, 510 lin.ft., at $5.85 per lin.ft.	2,984.10
Screening dike, 500 lin.ft., at $0.43 per foot	215.40
Filling roots, 2 at $59.57 each	119.15
Total	$16,585.85

500 lin.ft. 3-row concrete dike at $33.17 per lin.ft.

This dike went through the floods and ice of 1910 and 1911 without mishap, but was injured in the ice gorge and flood of the spring of 1912. The damage consisted in breaking off six piles and four braces at the lower end, disconnecting two piles on the outer row and eroding the brush and rock fill at the lower end. The ice gorge broke at this locality and the crushing and pushing force was irresistible. The damage done on four wooden dikes a few hundred feet below was very much greater. The concrete dike will be repaired at once. The injury was a reasonable one and does not disprove the value of concrete for such structures.

FIG. 6. LOWER PORTION OF THE CONCRETE REVETMENT AT GASCONADE, MO.

A further authorization is the construction of a concrete dike at Commerce Point, Pelican Bend,, on the right bank of the Missouri River near the mouth. The dike is to be 3-row, 4500 ft. long. The estimated cost is $25 per lin.ft., or about $112,500 for the total (Fig. 1).

Pelican Bend has always been a bad stretch. The fall of the river along the chute to be closed is 1.18 ft. per mi., while around the bend it is 0.77 ft., which agrees nearly with the average river slope.

The dike is primarily for the rectification of the right bank, as it will close the main one of the numerous chutes in Pelican Bend. Its first service will be in closing the chute and the second will be to act as a permanent structure and serve as revetment, hence the cost of a wooden dike ($15 per lin.ft.) for closing purposes, and later the construction of revetment ($10 per lin.ft.) for permanency will be combined in the first cost of the concrete dike.

It is proposed to do this work by hired labor and government plant. The concrete piles will be cast on the shore in the vicinity of the plant. The piles will be made 50 ft. or longer and the mattress wider than usual in order to prevent all possible scour.

CONCRETE BANK PROTECTION

The standard revetment now employed consists of grading the bank to a 1 on 3 slope, laying a woven willow mattress, 86 ft. wide, from about 3 ft. above low water and extending out over the river bed, and ballasting and sinking same; also paving the graded bank from inshore edge of mattress to top of the bank. The standard revetment has been the most durable revetment found. If, however, the paving (rip-rap) fails, or is injured by drift, the bank begins to erode and the willow mattress is lost and of no avail; and the injured portion generally requires repair and replacement.

To overcome this difficulty it was thought a substantial reinforced-concrete revetment could be placed, extending from the top of the bank to near the low-water line and from this point a system of connected concrete flexible blocks about 24 in. square could be placed, extending out beyond the lowest water. This protects the top bank, and also the weak point of the willow mattress, which is alternately wet and dry.

There has recently been placed a similar system of solid concrete on the Kansas River for levee and slope revetment, together with flexible blocks at the bottom for under-water protection. This work was done by the Kaw Valley Drainage District and contemplates in all some 10 miles of revetment.*

The first concrete-revetment work on the Missouri River by the United States was done at Gasconade, Mo. (Figs. 5-6). One thousand linear feet of bank was protected, as outlined above, as follows:

a. Standard Missouri River willow mattress 86 ft. wide, extending from low water out over the river bed, with ballasting. Actual length of mattress, 1030 ft.

b. Reinforced-concrete paving in 8-ft. strips, laid from top of bank down to edge of mattress. Bank graded to 1 on 3 slope, average width of slope, 49.5 ft. Concrete, 4 in. thick.

c. Flexible concrete block protection of reinforced-concrete blocks, anchored together and to the solid concrete covering, extending from the bottom edge of concrete covering out on willow mattress, an average distance of 10 ft.

The concrete as actually placed at Gasconade was in 8-ft. strips up and down the slope. That is, there were planes of separation up and down, but not horizontally. The concrete, in addition to the strand of wire rope, had a reinforcement of fence wire covering the whole area and placed with 2-in. concrete above and below the wire. This reinforcement was a 4-in. triangular mesh of wire 1/8 to 1/8 in. diameter, laid the full width and length of each strip. Probably this reinforcement should be made stronger, and in future work the equivalent of 1/4 in. wire will be used and the blocks separated each way about 6 to 8 ft.

The costs were as follows:

a. Willow mattress		
757 cords brush, at $0.892	$675.87	
776 cu.yd. ballast, at $0.746	579.09	
555 cu.yd. spalling, at $0.702	389.70	
Wire strand and clips	204.43	
Towboat service	784.00	
Labor, superintendence and miscellaneous	669.59	
		$5,302.68
b. Concrete paving		
1156 cu.yd. gravel, at $1.533	$1,772.35	
Grading bank, 1000 lin.ft., at $0.94607	946.07	
Reinforcement	749.32	
821⅓ bbl. portland cement, at $1.15	1,881.35	
		$6,294.08
c. Flexible concrete blocks		
120 cu.yd. gravel, at $1.533	$183.96	
Reinforcement	221.65	
Portland cement, 182 bbl., at $1.15	209.30	
Labor, etc., making blocks	1,636.00	
Labor, etc., placing	685.12	
		$2,936.03
		$14,532.79

Summary

Weaving and ballasting mattress, 1030 lin. ft., at $5.147 per lin.ft.	$5,302.68
Concrete paving and grading, 1000 lin.ft., at $6.294 per lin.ft.	6,294.08
Flexible concrete blocks in place	2,936.03
	$14,532.79

The sum of $1470 of the above was for extra slope fill and not properly

*This is described on p. 1194 of this issue.

chargeable to regular work. This leaves a new cost of $12,062.79, or about $12 per lin.ft.

The usual cost of standard Missouri River revetment with 86-ft. mattress, and bank graded to 1 on 3 and paved with rip-rap stone is from $8 to $10 per lin.ft. Revetment work is usually done on a linear-foot measurement, the number of square yards of bank paving depending on the height of bank above low water. The bank at Gasconade was of the usual height if not somewhat greater. The average area per linear foot of bank for a 1 on 3 slope and 86-ft. mattress is 14 to 16 sq.yd., and its cost is 50c. to 62½c. per sq.yd.

The revetment at Gasconade has been completed and presents a most satisfactory appearance, and is believed to warrant its use on a larger scale.

The War Department has recently authorized the construction of 12,000 lin.ft. of combined willow mattress and concrete revetment on the right bank of the Missouri River near Berger, Mo. It is believed that this work will be on a large enough scale to reduce the cost to a minimum and at the same time will be a fair test of its value compared with rip-rap protection. The details are the result of the previous experience at Gasconade, and are embodied in Fig. 3. The assistant engineers at the time this article was written on the Missouri River work are Geo. C. Haydon, Kansas City to the mouth, and F. W. Honens, Kansas City to Fort Benton.

Aviation Squadrons are reported planned for by the War Department, and if these plans should be sanctioned by Congress the U. S. Army would have one of the most thoroughly organized military aëronautic forces in the world. There would be five training schools, located in various sections of the country, for the instruction of regular army and militia officers. At each school would be sheds, workshops, storerooms, barracks, etc. Besides training officers, it is planned here to train enlisted men as mechanics, to test new devices, to study meterology, wireless telegraphy, military topography, sketching and aërial reconnoissance, the design of air ships, and the military features of aëronautics.

For each field army of regular troops there would be three aviation squadrons, one to each division and one for headquarters of the army. There would be two squadrons for the Philippine Islands, one for use in Hawaii, and one for Panama.

Equipment would also be grouped at 14 coast-defense stations, and the total equipment thus assembled would not be less than that of eight squadrons. There would finally be one squadron for each field division of organized militia.

In the report of Capt. W. I. Chambers, U. S. N., to the Bureau of Navigation of the Navy Department, it is recommended that the Department should organize, or foster the organization of, a national aërodynamic laboratory at a cost of about $200,000.

A Successful Budget-Method Protest, Illustrated by Extracts from the Report of the Bureau of Street Cleaning, Richmond Borough, New York City

An effort to secure recognition for unit costs and economic efficiency as a basis for making appropriations for maintenance work in city departments was begun by George Cromwell, President of Richmond Borough, New York City, and by his borough associates, more than two years ago and has at last met with partial approval by Mr. Cromwell's fellow members of the Board of Estimate and Apportionment. On Mar. 9, 1910, Mr. Cromwell recommended to the Board that such department heads as could base their estimates on "unit-cost data and [future] work requirements" should be allowed to ask for and should be given lump-sum appropriations, to be used during the year at his discretion. He also suggested that, where cost data are available, department heads be permitted to transfer employees from one grade to another of salary or wages, according to their ability and efficiency, instead of being compelled to pay the same salaries or wages to every man doing a certain kind of work. Another suggestion looked to an independent system of checking cost data, from outside the department concerned.

Nothing tangible having come from the recommendations just recited, Mr. Cromwell brought up the subject again in June, 1912. To reinforce and illustrate his arguments he also sent to the Board of Estimate a letter on the same general subject from Louis L. Tribus, consulting engineer and acting commissioner of public works of Richmond Borough (in charge of all bureaus), and also extracts from the 1911 report of J. T. Fetherston, assistant engineer and acting superintendent of street cleaning of the same borough.

In the letter by Mr. Tribus attention is called to the fact that for nearly ten years there has been no change in the administrative heads of the borough. This has made it possible to pursue the work in hand with the constant aim of "securing for the public a dollar's worth of benefit for each dollar expended." In the pursuit of this object the effort has been to know how much work of each class ought to be done, how much is actually done, what the unit cost has been and how this cost compares, as far as comparable, with costs for like work done elsewhere.

In the earlier part of the ten-year period lump-sum appropriations were the rule, but recently, Mr. Tribus states, a serious handicap has resulted from the adoption "of a highly segregated budget" which aims to prescribe to the Bureau, "about nine months in advance, just how its money should be expended as to proportions of materials and labor, and just what should be paid to each man as a member of a class, regardless of individual ability and usefulness." Applications for transfers and merited increases of pay are either refused or else delayed for weeks or months or even for years.

Mr. Tribus expresses the belief that while segregation of funds may be useful from an accounting standpoint, "it is the work to be done that is of importance, and segregation of funds fails utterly to recognize the important factors that make for the success or failure of the work itself." Mr. Tribus believes that the undoubted savings of city moneys in the last few years have not resulted from the segregated budget, but rather from the "greater care taken by officials in planning and handling their work, and greater care in appropriating for necessities rather than for non-essentials." Continuing, Mr. Tribus says:

> We believe that far greater saving could have been effected, and may yet be effected, by a return to the lump sum appropriation method, but to be accompanied by a constant supervision and audit of work done, by competent experts appointed by the Board of Estimate and Apportionment, together with publication of frequent and regular reports as to the work accomplished and the unit costs thereof, compared with preceding periods, and eventually with scientifically determined standards.

Mr. Tribus then offers Mr. Fetherston's report for 1911 (already mentioned) as affording further evidence of the handicaps due to over dependence on the segregated budget alone and in illustration of useful cost data. Extracts from the report follow.

Extracts from the Report of J. T. Fetherston, Acting Superintendent of Street Cleaning, Borough of Richmond, New York City

General Observations—For a number of years this Bureau has persistently attempted to increase the efficiency of its operation, both with regard to adequate performance of work, and economical administration of funds. The results, while eminently satisfactory as indicating substantial progress, are, it is believed, still far below standards of possible achievement. The improvements in efficiency were due principally to the maintenance of systematic procedure and methods, insistence on strict discipline, careful analysis of costs, and prompt application of remedial measures to faults developed by such analyses. Of late, however, especially during the past two years, the Bureau seems to have reached a point where such methods are no longer effective in maintaining the desired rate of progress. Despite determined efforts during the year 1911 to secure a noticeable increase in efficiency, it has been practically impossible under the ex-

isting regulations of the fiscal authorities to improve materially on past performances. This serious condition confronting the Bureau requires explanation, and seems to demand for its amelioration a modification of the financial procedure of the city.

Broadly speaking, a municipality is a monopolistic corporation, and, as such, its operations are not subject to the effect of competition, or some satisfactory substitute therefor. A city differs from a private corporation, in that its operations are, almost without exception, performed at cost rather than for profit. The effect is consequently apparent in the form of uncontrolled results, as, for instance, extravagance, or inadequate performance, or both. Officially no recognition is given in New York to results, as measured by the relation of accomplishment to expenditure, nor has any serious attempt been made to control the city's activities by such means.

The annual tax budget, through which power over the city's operations is secured, takes no account of measurable services to be rendered or physical results to be accomplished (in a word, the efficiency of performance), but considers only the intermediate and minor steps involved in the expenditures contemplated. Thus, without a criterion of accomplishment, or a substitute for the personal incentive provided by the profits of commerce, the attempt to secure efficiency in municipal affairs is seriously handicapped, and the ambitious administrator is practically limited to that degree of success which can be secured by enforced obedience, while the disinterested official suffers not even the inconvenience of merited censure.

It is, without question, this lack of ability to offer an adequate incentive to its employees which has prevented this Bureau from securing the desired reduction in unit costs during the last year. The resources of dictatorial measures have been practically exhausted, and any further improvement in the performance of its personnel must come as a result of substantial rewards for increased output.

Fig. 1 illustrates graphically the present fiscal ideal in the control of expenditures and is based upon cash-accounting methods, with extreme segregation of salaries, wages, supplies, renewals, repair funds, etc., and proportional monthly disbursements predicated in advance. New budget allowances are generally based upon past expenditures, and, in this way, waste may go on for years undetected. Little discretion is allowed department heads as to the effective use of the "sinews of war," and there is no incentive to economize, especially when the saving may result in a penalty imposed in the form of a reduction in subsequent appropriations. The situation thus summarized has been called to the attention of the controlling body of the city (Mar. 9, 1910) by the President of the Borough of Richmond, who has suggested that the Board of Estimate and Apportionment reform the system of planning annual expenditures by recognizing the necessity for controlling costs and establishing work records in all departments where the objects to be accomplished can be reduced to measurable form, either in the way of service rendered, or physical work accomplished. If President Cromwell's proposed method is adopted, responsibility and power can be allowed to department heads, and physical statistics can be checked by an independent division of the city's forces in the same way that the Comptroller now audits cash payments.

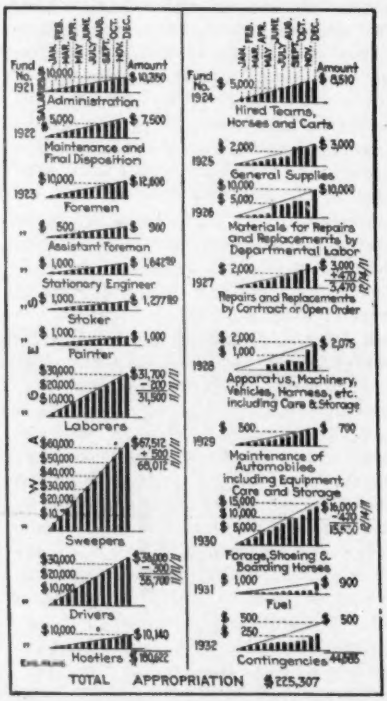


FIG. 1. GRAPHICAL ILLUSTRATION OF THE CASH-ACCOUNTING SYSTEM OF CONTROLLING EXPENDITURES FOR THE BUREAU OF STREET CLEANING, RICHMOND BOROUGH, NEW YORK CITY

The growth of budgetary appropriations in New York from $26.41 per capita in 1900 to $32.26 per capita in 1910, and the increasing pressure for new municipal developments require that economy and real efficiency (depending upon positive, aggressive, and affirmative action) shall replace present negative methods of government, which are proving inadequate for meeting modern demands of urban life.

COMPARATIVE SUMMARY OF STREET-CLEANING WORK—All that the city now requires in the way of statistics necessary in an annual report [is a monthly statement of disbursements charged against each of the segregated items comprising the total appropriations—ED.], though it is usual to supplement the disbursements with a general account of the difficulties overcome and probably some suggested improvements required to conduct the work more "efficiently." It will be noted that the statistics referred to relate entirely to expenditures, with no mention whatever of work accomplished.

Table I illustrates one feature of President Cromwell's suggestions for reporting a year's work in the Bureau of Street Cleaning. The above table provides a substitute for the competition of commerce, and shows on a relative basis a total saving or profit of $8014 for 1011 over 1910, and $10,001 for 1911 over 1909. It is true that the Bureau is its own pacemaker, but no better method is permissible under existing restrictions.

For ten years cost records have been maintained in this Bureau, and an

TABLE I. COMPARISON OF MAINTENANCE COSTS—1909-1910-1911

Quantity of work performed in 1911		Class of work	1909 Unit costs	1909 Total cost	1910 Unit costs	1910 Total cost	1911 Unit costs	1911 Total cost
27,015.3	miles	Street cleaning by hand and machine brooms	$3.15	$85,008	$3.11	$84,017	$3.14	$84,813
113,500	cu.yd.	Refuse collection, household wastes and street sweepings	0.60	68,100	0.58	65,830	0.57	64,515
113,500	cu.yd.	Final disposition, dumps and destruction	0.158	17,933	0.157	17,819	0.15	17,097
42,190	cu.yd.	Snow removal, roadways	0.17	7,172	0.17	7,172	0.19	8,201
1,552.4	miles	Cleaning gutters by hand and plow	4.59	7,126	5.39	8,367	4.59	7,126
12.76	miles	Cleaning snow from sidewalks	58.55	747	65.08	830	78.97	1,008
262.2	miles	Cleaning snow from crosswalks	6.18	1,620	5.96	1,563	6.52	1,710
1,525.4	cu.yd.	Spreading ashes, sand, etc., on slippery streets	2.42	3,691	2.03	3,097	2.52	3,839
3,408.7	cu.yd.	Light repairs to macadam	3.27	11,382	3.20	11,148	3.20	11,148
.....		Surfacing streets	.....	7	.....	7	.....	.....
292,257	sq.yd.	Weeding gutters and wings of road ways, per mile	3.00	877	5.40	1,578	5.31	1,551
.....		Miscellaneous charges	.....	15,586	.....	15,509	.....	11,067
.....		Inter-Bureau charges	.....	7,837	.....	5,387	.....	4,649
.....		Deferred and outstanding charges	.....	5,086	.....	6,143	.....	4,222
.....		Office-clerical and supervisory	.....	8,577	.....	10,325	.....	9,892
		Total	.....	$240,839	.....	$238,852	.....	$230,838
		Brought forward 1911 cost	.....	230,838	.....	230,838	.....	.....
		Total relative credit in favor of 1911	.....	10,001	.....	8,014	.....	.....
Comparative Credit-Unit Cost Work:								
		Total expenditure	.....	$240,839	.....	$238,852	.....	$230,838
		Total of four non-unit items (Miscellaneous, Inter-bureau, deferred and outstanding charges and office)	.....	37,086	.....	37,424	.....	29,830
		Relative cost of physical unit work	.....	203,753	....	201,428	.....	201,008
		1911 brought down	.....	201,008	....	201,008	.....	.....
		Relative credit-physical unit work	.....	$2,745	.....	$420	.....	.....

analysis shows the effect of this work when comparison is made of average annual unit costs of the various activities for which physical results are available. By deducting from the total amounts in Table I, the non-unit divisions of work for the three years, it will be found that the relative saving for 1911 over 1910 was $420, and for 1911 over 1909 the saving was $2745. This means, in effect, that for the same amount of work performed the actual cost has nearly reached a minimum under the existing conditions. Further economies in the classified activities of the Bureau must be secured, either by changes in regulations governing the work, or in methods of performing the duties imposed by law. Both regulations and methods are susceptible of improvement if a positive instead of a negative procedure is adopted as the "rule of reason" by the municipality.

SCIENTIFIC MANAGEMENT—During the past few years, a great effect has been produced on the management of industrial concerns through the work of Frederick W. Taylor, Harrington Emerson, and other engineers, who have deduced principles relating to the efficiency of the work of men and machines in industrial plants. These principles are applicable to practically all municipal activities, though their application must necessarily be modified to meet the conditions of city work.

In our Bureau of Street Cleaning, all work has been planned and scheduled in advance; instructions are written and served upon the individual workman; responsibility is fixed and definite; rules governing discipline are in force; cost records are compiled, analyzed and compared; tests and time studies of various classes of work are made as far as possible with the men and means available; and generally efforts for betterments are constantly under consideration. But ability and efficiency on the part of employees are not promptly recognized by the city, hence the natural tendency is to ask, "What's the use"? Colonel Waring well stated the situation in his book on Street Cleaning: "My work has succeeded because it was done for its own sake alone." It is fifteen years since Colonel Waring's term of office expired, and it may be remembered that, in spite of his work, character, and reputation, the people did not insist on retaining him in office. Department heads today who are in any measure successful "do the work for its own sake alone." Inevitably a department reflects the character of its chief, and, with short terms of office and new heads, no continuity in administration, no practical ideals to strive for, no incentive for the workers in the ranks, it certainly is time for the higher municipal officials to revise present antiquated methods of conducting municipal business.

TABLE III. CHARGES AND ACTIONS AGAINST EMPLOYEES FOR VIOLATIONS OF "GENERAL ORDERS," 1911

Number of Charges Preferred	Action taken: Dismissals	Action Deferred	Guilty: Fined	Guilty: Fines in Days pay	Guilty: Warned	Guilty: Deduction in Efficiency Record	Not Guilty
61	10	16	6	30	5	18	6

COMPLAINTS — More complaints were received from citizens in 1911 than for any year since 1904. Of the 92 complaints, 82 were received on account of the non-collection of refuse, and, on investigation, it was found that in 59 of the cases there was either no cause for complaint, or the complainant was at fault for not complying with city ordinances. Nearly all of the 23 complaints chargeable against the Bureau for the non-collection of refuse were due to a rearrangement in the collection routes. The economy proposed by this change in routes was only partially successful, as the collectors could receive no recognition for increased work under the existing flat wage rate, and this attempt to secure greater efficiency illustrates the difficulty of obtaining coöperation on the part of employees without providing some incentive for their efforts in securing betterments.

PERSONNEL—The number of employees of various grades in the Bureau since the organization of Street Cleaning work under the Borough President in 1902, and the salaries or wages for 1911, are shown in Table II and Table II A.

To maintain discipline in the force, the rules of the service have been followed consistently, and 61 charges for violations of the regulations have been preferred against employees, with results as shown on Table III.

Efficiency records of all employees, including laborers, sweepers, and drivers, have been maintained, and the men rewarded for good work by days off with pay, or recommended for dismissal on account of low marks. One of the greatest needs of the Bureau is some simple means for rewarding efficient employees by direct increases in wages, or for punishing inefficient men by reductions in wages. In this way coöperation can be secured through self-interest, while under the existing system work must be accomplished mainly through fear of punishment, as the few days off with pay allowable for good records is only a make-shift, and can never replace the direct incentive of a wage increase.

SANITARY WORK—Of the total expenditures in the Bureau during 1911, $166,425.49 was used in "Sanitary Work," including the sweeping and cleaning of streets, the collection, removal, and final disposition of refuse. The population in 1911 was approximately 90,000, and the area of the Borough 57 sq.mi. The length and area of different kinds of street pavement in charge of the Bureau for cleaning and light repairs, by comparison with the two previous years, is shown in Table IV.

TABLE II. EMPLOYEES—BUREAU OF STREET CLEANING

Position	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911
Superintendent	...	1	1	1	1	1	1	1	1	1
Asst. superintendent	...	...	...	...	...	...	...	...	1	1
Clerks	...	1	2	3	4	4	4	4	4	4
Inspectors	1	1	3	4	4	6	6	6	5	5
Foremen and asst. foremen	5	10	11	9	14	11	14	12	11	11
Stationary engineman	...	...	...	...	...	...	1	1	1	1
Stoker	...	...	...	...	...	...	1	1	1	1
Auto engineman	...	...	...	...	1	1	1	...	...	...
Laborers and sweepers	67	118	119	122	120	116	124	123	147	130
Drivers and hostlers	1	1	1	60	56	61	62	58	90	83
Painter	...	...	...	...	...	...	...	...	1	1
Hired carts	28	42	14	8	8	8	8	8	8	8
Totas	103	174	151	206	208	208	222	214	246	235

TABLE IV. PAVEMENTS FOR CLEANING AND LIGHT REPAIRS (MACADAM)

Character	Mileage 1909	Mileage 1910	Mileage 1911	Sq.yd. 1911
Granite block	5.7	5.9	5.6	113,658
Medina block	0.0	0.2	0.3	6,794
Sheet asphalt	1.1	0.5	0.4	6,494
Block asphalt	9.8	9.5	9.5	185,019
Wood block	0.2	1.3	2.7	54,163
Iron slag block	0.8	1.9	2.1	45,616
Vitrified brick	3.8	4.2	4.5	90,265
Bituminous concrete	2.7	2.7	6.0	99,502
Concrete	0.0	0.1	0.2	2,920
Bituminous macadam	0.0	5.3	8.1	99,905
Macadam	104.8	102.9	99.0	984,555
Totals	128.9	134.5	138.4	1,688,891

TABLE II A. SALARIES AND WAGES IN 1911

Position	Per Annum $3000	$1800	$1650	$1500	$1200	$1050	$1000	$900	$780	$720	Per Day $4.50	$3.50	$2.25	$2.00
Superintendent	1	...	...	...	...	...	...	..	..	..	...	...	...	...
Assistant superintendent	...	1	...	...	...	...	...	...	..	..	...	...	...	...
Clerks	...	1	1	...	1	...	...	1	..	..	...	...	...	...
Inspectors	...	...	...	5	...	...	...	...	..	..	...	...	...	...
Foremen and assistant foremen	...	...	...	...	6	4	...	1	..	..	...	...	...	...
Stationary engineman	...	...	...	...	...	...	...	..	..	..	1	...	...	...
Stoker	...	...	...	...	...	...	...	..	..	..	...	1	...	...
Laborers and sweepers	...	...	...	...	...	...	...	9	..	119	...	...	...	11
Drivers and hostlers	...	...	...	...	...	...	...	2	13	40	...	...	8	...
Painter	...	...	...	...	...	...	1	..	..	..	...	...	...	...
Hired carts	...	...	...	...	...	...	...	..	..	..	...	8	...	...

STREET CLEANING — Practically all street-cleaning work in 1911 was performed by hand broom, and the cost increased 4c. per mile over 1910. The higher unit cost was due to a very dry season, the dusty condition of many of the streets, the continual falling of leaves from trees affected by the drought, and some badly worn asphalt-block pavements, which necessitated the employment of additional sweepers in order that the general quality of the work might be maintained. Application was made for money to secure four horse-drawn street-flushing machines, but the funds were not made available until too late in the season. A detailed study was, therefore, made of the possibility of replacing horse-drawn flushers by power operated flushing machines, which resulted in the conclusion that an electrically operated combination street-flushing machine and

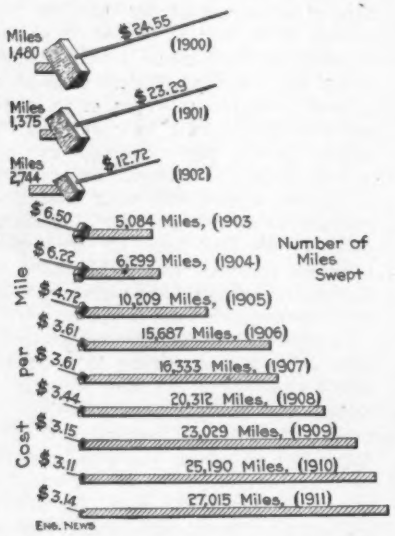


FIG. 2. GRAPHICAL EXHIBIT OF UNIT COSTS OF STREET CLEANING AND TOTAL MILES CLEANED, BOROUGH OF RICHMOND, 1900 TO 1911, INCLUSIVE

power truck would prove more economical than the horse-drawn machines, as power for charging the batteries will be available without additional cost at the West New Brighton Refuse Destructor. Most of the paved streets in charge of this Bureau adjoin macadam pavements, and a great deal of grit, dust, and dirt is carried over to the improved pavements by vehicular traffic, thus the nuisance from dust has been increasing with the greater popularity of fast-moving automobiles. It is hoped that a flushing machine, or some form of vacuum cleaner, will help to meet this condition, and enable the Bureau to remove even fine dust from the roadways. The cost of street cleaning (30-ft. roadway), per mile, by comparison with previous years, is shown graphically by Fig. 2. The average area cleaned per man in 1911 was 16,326 sq.yd. per productive day's work. The average amount of material removed per 1000 sq.yd. cleaned was 2.05 cu.ft., and the cost per 1000 sq.yd. swept, including the removal and disposal of the sweepings therefrom, was 20c.

REFUSE COLLECTION—HOUSEHOLD WASTES—The cost of collecting household wastes decreased 1c. per cu.yd. by comparison with 1910. No trade waste was collected during the year, and business houses were required to remove material at their own expense, the city taking care of the final disposition of the

TABLE V. STATISTICS OF EMERGENCY SNOW REMOVAL FROM ROADWAYS—1911

Time of Storm—1911	Depth of Snow, in.	Total Area Cleared, sq.yd.	Snow removed Area Basis, cu.yd.	Snow removed Wagon Measurement, cu.yd.	Approximate Shrinkage, per cent.	Total cost of removal	Cost per cu.yd. Area Basis	Cost per cu.yd. Wagon Measurement
Feb. 20	6	212,197	29,470	14,348	49	$2,366.53	$0.08	$0.165
Dec. 3 & 4	5	232,137	32,243	11,666	64	1,930.65	0.06	0.165

TABLE VI. BUREAU OF STREET CLEANING MAINTENANCE, APPROPRIATIONS, EXPENDITURES AND UNIT COSTS FOR THE YEAR 1911

General Summary

Fund No.	Title	Appropriation	Expenditure
	Administration		
1921	Salaries (Office and Clerical Force)	$10,350.00	$9,891.93
	Maintenance and Final Disposition		
1922	Salaries	7,500.00	6,841.66
1923	Wages	162,772.00	160,976.72
1924	Hired teams, horses and carts	8,510.00	8,503.00
1925	General supplies	3,000.00	2,940.28
1926	Materials for repairs and replacements by departmental labor	10,000.00	9,910.23
1927	Repairs and replacements by contract or open order	3,470.00	3,109.98
1928	Apparatus, machinery, vehicles, harness, etc. including care and storage	2,075.00	2,068.80
1929	Maintenance of automobiles, including equipment, care and storage	700.00	666.77
1930	Forage, shoeing and boarding horses	15,530.00	14,654.12
1931	Fuel	900.00	841.32
1932	Contingencies	500.00	297.49
R-PR-9A	Revenue Bonds—Removal of snow and ice	10,000.00	5,070.15
	Supplies bought on 1910 appropriation and wages of men detailed to B.S.C. and paid from sewer bureau funds		5,065.34
		235,307.00	230,837.79
	Deduct for supplies bought on 1910 appropriation and snow charges paid by sewer bureau		5,065.34
	Deduct unexpended balance	9,534.55	
		225,772.45	225,772.45

Details of Expenditures—Unit Costs—Maintenance and Final Disposition.*

Fund Number Classification of Work	Totals	Quantities	Unit costs	Remarks
Street cleaning by hand broom	$84,809.71	27,014 miles	$3.14 per mile	Average cost per mi. $3.14
Street cleaning by machine broom	3.87	1.3 miles	2.98 per mile	
Refuse collection, household wastes	51,670.74	77,290 cu.yd.	0.67 per cu.yd.	Average cost per cu.yd. 57c.
Refuse collection, street sweepings	12,844.38	36,210 cu.yd.	0.35 cu.yd.	
Final disposition at dumps	5,314.90	95,348 cu.yd.	0.05½ cu.yd.	
Final disposition at W.N. Brighton destructor	11,781.89	9,244 tons	1.27 ton	
Snow removal from roadways	8,201.53	42,190 cu.yd.	0.19 per cu.yd.	
Clearing gutters of snow and mud by hand	7,098.34	1,503.4 miles	4.72 per mile	Average cost per mi. $4.59
Clearing gutters of snow and mud by plow	27.66	49 miles	0.56 per mile	
Clearing snow from sidewalks	1,007.61	12.76 miles	78.97 per mile	
Clearing snow from crosswalks	1,709.60	262.2 miles	6.52 per mile	
Spreading ashes on slippery streets	2,803.99	1165 cu.yd.	2.41 per cu.yd.	
Spreading sand on slippery streets	963.34	342 cu.yd	2.82 per cu.yd.	
Spreading screenings on slippery streets	71.88	18.4 cu.yd.	3.91 per cu.yd.	
Light repairs to macadam roadways	11,148.21	3480.68 cu.yd.	3.20 cu.yd.	
Weeding gutters, etc	1,551.20	292,257 sq.yd.	53c. per 100 sq.yd.	
Miscellaneous charges, see Item A‡	11,066.70			
Inter-Bureau charges, see Item B‡	4,648.73			
Deferred and outstanding charges—Item C†	4,221.49			
Totals	220,945.86			

Recapitulation (Check Account) Maintenance and Final Disposition

Supervision, salaries	6,841.66
Supervision, wages regular employees	15,954.74
Labor, wages regular employees	145,021.98
Hired teams, horses and carts (country routes)	8,503.00
R-PR-9A Removal of snow and ice, supervision	602.02
Labor	1,575.19
Hired teams and carts	2,816.29
Contingencies	76.65
Labor and carts detailed from sewer bureau and paid from their own funds	9.60
Teams, horses and carts detailed from sewer bureau and paid from their own funds	128.36
General supplies	2,940.28
Materials for repairs and replacements by departmental labor	9,910.23
Repairs and replacements by contract or open order	3,109.98
Apparatus, machinery, vehicles, harness, etc. including care and storage	2,068.80
Maintenance of automobiles, including equipment, care and storage	666.77
Forage, shoeing and boarding horses	‡15,863.99
Fuel	841.32
Contingencies	297.49
Supplies bought on 1910 Funds	3,717.51
Total	220,945.86

*We have omitted 12 columns between the stub of the table and the column of totals. The columns thus omitted showed a distribution of the stub items by the "Fund No." stub items in the first division of the table.—Ed.

†We have omitted detailed tables showing the distribution of these items among objects chiefly of local interest.

‡Value of forage carried over from 1910, $1210.

wastes, either at the West New Brighton Destructor or at the various dumping places. The cost per capita likewise decreased 1c. per annum for the population served by the refuse collectors. The average amount of material removed per productive work-day was 8.7 cu.yd. Efforts to reduce collection costs were made by rearranging schedules, with but partial success, and further decreases in unit costs must be secured by improving present equipment and offering an incentive to secure coöperation on the part of the refuse collectors.

REFUSE COLLECTION—STREET SWEEPINGS—The cost of removing street sweepings decreased 3c. per cu.yd. by comparison with last year. Each unit (cart and driver) removed on the average of 14.1 cu.yd. per productive work-day. A test was made with a large automobile truck collecting refuse from households, but it was found that there was no economy in the power truck over a horse-drawn vehicle, as the number of stops and the time required to load the truck was not offset by the gain in speed due to the length of haul to the point of disposal. It is probable, however, that a power truck will be found economical in collecting street sweepings which are scattered over a large teritory and where speed will be a controlling factor.

FINAL DISPOSITION—AT DUMPS—The cost of caring for dumps decreased ½c. per cu.yd. by comparison with the previous year, and the amount of material cared for at the dumps per man per actual work day was 79 cu.yd.

FINAL DISPOSITION—AT WEST NEW BRIGHTON REFUSE DESTRUCTOR — The West New Brighton refuse destructor has now been in operation 3½ years without complaint of nuisance from odors. The cost of disposal in 1911 was 7c. less per ton than in 1910, and, in addition, clinker having an estimated value of $870 was used for structural purposes. No complete utilization of the steam power developed at the plant is yet available. The same number of men are employed as were necessary during the tests of the plant in 1908, and the yearly cost of disposal has been mainly affected by variations in the quantity of material delivered to the plant. The engineers' house, on Richmond Terrace adjoining the plant, was completed early in 1911, and gateways, sidewalks, and retaining-wall made of clinker concrete were built by city employees, thus finishing the approaches to the plant. The amount of material burned per productive man, per actual work-day during 1911 was 3.39 tons.

SNOW REMOVAL FROM ROADWAYS—During the year 1911 the snowfall amounted to 28 in., of which 11 in. were removed from roadways by emergency gangs. Table V summarizes the essential feature of this class of work.

The final cost of snow removed from roadways by vehicular measurement in 1911 was 19c. per cu.yd. The difference in unit cost between Table V and the final cost per cubic yard is due mainly to the removal of ice by city carts after emergency work was finished.

[Several paragraphs on cleaning snow from sidewalks, etc., and on spreading ashes, etc., on slippery streets are omitted.—ED.]

LIGHT REPAIRS TO MACADAM ROADS—A considerably greater amount of macadam light repairs was performed in 1911 than in 1910, as a larger sum of money was available for the purchase of broken stone, though all the stone could not be used during the year, because men and teams were not available for hauling the material. This illustrates one of the difficulties of trying to secure results under strictly segregated appropriations, as money may be allowed for supplies which can be used for no other purpose, yet labor and equipment necessary for the best utilization of the materials is not provided.

The lack of water for sprinkling purposes in 1911 tended to destroy the water-bound macadam roads, and required extraordinary measures to maintain this class of pavement. By spreading ¾-in. stone over water-bound macadam roadways which showed signs of disintegration, it was possible, in most cases, to replace the binding material, and thus save the roadways in charge of the Bureau from complete destruction. On a labor basis, 19 cu.yd. of broken stone were spread over various road surfaces per productive work-day, while on a vehicular basis, 4.75 cu.yd. of material were placed per productive work-day.

[Paragraphs on weeding and various topics of local interest are omitted here. —ED.]

FINANCIAL STATEMENT—The financial statement [partly given in our Table VI —ED.], which follows in tabular form, explains the expenditures of the Bureau in detail, and provides statistical information as to the actual expenditures and physical results obtained.

COST-KEEPING—Cost-keeping is one of the most important divisions of work in

TABLE VII. PORTION OF THE 1913 STREET CLEANING BUDGET, PRESIDENT OF THE BOROUGH OF RICHMOND, NEW YORK CITY

Functional work classification	Units of measure	Work Quantities: Present work	Work Quantities: New work	Departmental Service: Total	Departmental Service: Average Unit cost	Departmental Service: Item cost	Total cost	Distribution: Payroll charges	Distribution: Material and supplies charges	Distribution: Plant and equipment charges
1st quarter 1913:										
Street sweeping	Miles	5,318.00	.....	5,437.6	$3.37	$18,411.07		$17,738.53	$536.63	$135.91
Street flushing	Miles		200	200.0	1.37	273.42		240.10	26.66	6.66
Refuse collection	Cu.yd.	28,044.0	.....	29,612.5	0.61	17,738.28		13,933.07	3,553.50	251.71
Final disposition—dumps	Cu.yd.	23,526.0	.....	20,476.8	0.07	1,353.39		1,222.34	120.81	10.24
Final disposition—destructors	Tons	2,466.09	2336.31	4,802.4	0.95	4,625.73		4,342.39	246.84	36.50
Snow removal	Cu.yd.	29,597.	.....	35,372.7	0.20	7,074.69		6,537.02	509.37	28.30
Cleaning sidewalks, gutters, etc. of snow and mud	Miles	1,140.41	.....	1,189.6	5.35	6,364.19		6,224.18	108.13	31.88
Ashing and sanding streets	Cu.yd.	937.55	.....	983.7	2.17	2,120.16		1,724.02	374.89	21.25
Light repairs, macadam	Cu.yd.	383.8	.....	386.	4.24	1,633.38		487.31	1,136.27	9.80
Weeding	Sq.yd.	.....	.....	....	....	.....		.....	.....	.....
Miscellaneous	....	.....	.....	....	....	1,101.17		983.35	114.52	3.30
Inter-Bureau	....	.....	.....	....	....	1,291.21		513.90	717.91	59.40
Total 1st quarter							$61,986.69	53,946.21	7,445.53	594.95
Total for Year:										
Street sweeping	Miles	27,014.3	.....	28,000.	3.37	94,423.51		90,710.57	3,045.36	667.58
Street flushing	Miles	.....	1500	1,500.	1.37	2,050.00		1,800.00	200.00	50.00
Refuse collection	Cu.yd.	108,905.	.....	115,000.	0.64	73,526.00		57,953.51	14,547.29	1025.20
Final disposition—dumps	Cu.yd.	90,764.	.....	79,00.0	0.07	5,900.00		5,380.59	480.23	39.18
Final disposition—destructors	Tons	9,244.720	8755.28	18,000.	1.04	81,660.00		17,506.29	1,004.79	148.92
Snow removal	Cu.yd.	42,1290.	.....	43,600.	0.20	8,720.15		8,057.43	627.84	34.88
Cleaning sidewalks, gutters, etc. of snow and mud	Miles	1,821.31	.....	1,900	5.72	10,861.00		10,622.03	184.61	54.36
Ashing and sanding	Cu.yd.	1,524.9	.....	1,600	2.69	4,307.00		3,594.18	759.73	43.09
Light repairs, macadam	Cu.yd.	3,480.14	.....	3,500.	3.66	12,794.00		3,824.50	8,892.84	76.66
Weeding	(per C. Sq.yd.)	292,257.	.....	200,000.	0.85	1,697.00		1,668.19	21.96	6.85
Miscellaneous	....	.....	.....	.....	....	4,349.00		3,883.67	452.30	13.03
Inter-Bureau	....	.....	.....	.....	....	4,995.00		1,988.01	2,777.22	229.77
Totals for year							242,282.66	206,898.97	32,994.17	2389.52
Capital investment for year							9,590.00			
Amount							251,872.66			
Special revenue bonds, snow removal							5,070.15			
Tax Levy part allowance							$246,802.51			

the Bureau, as by it alone can real efficiency be measured in comparison with past records, standards, or ideals. Yet cost-keeping is not recognized as essential by the general city authorities, and it has been impossible to make it of greater value than at present, because appropriations cannot be used with advantage in standardizing or securing additional statistical data which would enable greater efficiency and economy to be obtained in the work of the Bureau.

CONCLUSION—As a result of eight years' experience in the Bureau of Street Cleaning, it would appear that the greatest need at present in sight for the betterment of the service concerns the method of appropriating funds so that responsibility, power, incentive and initiative may be secured and maintained.

There are many economies which can be effected in the organization and work of the Bureau, while efficiency in general can be increased, if the lawmakers and the financial bodies controlling the city desire real economy through efficiency, and will revise the present restrictive regulations, adopting in their stead affirmative and progressive policies.

THE COST DATA BUDGET PLAN TO BE GIVEN A PARTIAL TRIAL

On Oct. 31, 1912, the Board of Estimate and Apportionment adopted a portion of the recommendations of the Richmond Borough officials. Accordingly, the 1913 appropriations for the Bureaus of Highways, Sewers and Street Cleaning will be classified functionally and will be based on work quantities to be performed in each quarter of the year and on average unit and item costs. Just what this means is stated more particularly in the following resolutions:

(1) The nature of all expenditures shall fall within the scope of the work classifications specified in the supporting schedules.

(2) The total cost allowances shown therein for any quarter shall not be exceeded within that quarter.

(3) The total allowance for capital investment shall not be exceeded during the year.

At the end of each quarter of the year there shall be presented to the Board of Estimate and Apportionment a detailed statement of all the operations of the above mentioned bureaus and the cost thereof, together with a reconciliation schedule showing the relation between total costs of work and total expenditures, in such form as may be prescribed by the Board. At the same time requests for modifications of the remaining schedules may be presented for consideration and action of the Board.

The Board shall be notified in advance of the commencement and cessation for all regular work covered by the supporting schedules.

The quantity of any item of work performed in a given quarter shall not exceed or underrun by more than 10% the quantity specified for that item in the supporting schedules, without advance notification to the Board of Estimate and Apportionment.

The "supporting schedules" mentioned in the resolution were in the form of detailed schedules for each quarter of the year and for the whole year—thus permitting variations which will follow seasonal requirements more or less closely. By way of illustration we reprint (Table VII) the Bureau of Street Cleaning schedule for the first quarter of the year and the totals for the year.

There was also presented to the Board of Estimate a resolution establishing the positions, number of employees and wage rates for each position in each of the three bureaus. The novel feature of these schedules was that instead of a single rate of pay for inspectors, foremen, and the various classes of laborers from two to four rates of pay were provided, and instead of a hard and fast number of laborers the number was "unlimited."

The whole spirit of the new appropriation scheme, it will be seen, is to try to secure a stipulated amount of work at a minimum cost, instead of putting hard and fast limits on expenditures for this and that sort of materials, supplies, and class of labor, segregated by "funds" or items, most of which have no relation whatever to either the kind or the amount of the work undertaken—as may be seen by again examining Fig. 1 and Table VI.

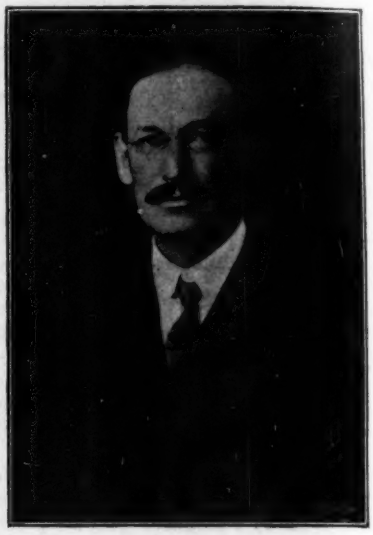
A 600-ft. Steel Arch Bridge has recently been completed across the River Vilaine near La Roche-Bernard, in France, to carry one of the national highways from the city of Nantes to the town of Audierne. The crossing is the site of several previous bridges. In 1840 a notable suspension bridge with a clear span of 635 ft. and a height above highest tide of 108 ft. was built by the government engineers, and remained a monument to their ability for over 30 years. In 1871 this bridge was completely destroyed by a heavy storm. Immediately thereafter a temporary suspension bridge 10 ft. wide, instead of the 23-ft. original structure, was built to replace the one destroyed. In 1905 the government decided to replace this small suspension bridge by a large and permanent arch.

The new bridge has a main span 600.4 ft. wide between inside faces of the steel at the skew back, and is approached on either side by a Series of three high masonry arches. It has a roadway 18 ft. wide with a 2½-ft. sidewalk on each side. It is designed to carry highway traffic, and at present is provided with one interurban railway track. The main span is an arch, as before stated, 600 ft. in span and 164 ft. in rise, with the roadway level midway up the arch, 108 ft. above the skewback level. The portion of the structure above the roadway consists of a three-hinged arch, 368 ft. in span and 49.4 ft. in rise, hinged at the crown and at the roadway level. The lower portion of the arch is composed of two inclined piers forming in appearance the haunches of the arch, but structurally, rigid frameworks rising on the incline of the arch out of the masonry skewback and carrying at their upper elevation the hinges on which the upper three-hinged arch rests.

David White

The appointment of David White as Chief Geologist of the United States Geological Survey was noted in our personal columns a few weeks ago. Mr. White has been associated with the Geological Survey for more than 25 years and is well known among geologists for his paleontological work. He is now President of the Paleontological Society.

For many years Mr. White has made a specialty of the study of the fossil



DAVID WHITE

floras of the older geological formations and has contributed much to the history of the deposition of the coal measures in several basins. Mr. White will be remembered by the readers of ENGINEERING NEWS as the author of the article in our issue of Oct. 17 on the oil-shale deposits of the United States.

A Railway Terminal Plan for Chicago, which has been designed by Jarvis Hunt, architect, proposes a concentration of all main-line or through passenger service and all down-town freight service within one immense double-deck terminal. The site suggested extends from 12th St. south to Archer Ave., and from State St. west to a new river channel just east of Canal St., this channel taking the place of the present winding channel between Van Buren and 20th Sts. The passenger station would extend from 12th to 16th Sts. (about half a mile), beyond which would be the freight houses and team tracks, while other freight facilities would be beneath the passenger station. The location is farther south than any existing terminal, but 12th St. has been proposed for many terminal projects, it being claimed that the business district will extend eventually to that point. Nearly all of the property included in the new project is owned by the railways, and it is estimated that the railway property released and made available for commercial use by the abandonment of the several existing terminals would have a value of $200,000,000.

A Notable Water-Supply Report

As an outcome of the struggle to prevent San Francisco from carrying out its project for a municipally-owned water-supply from the Tuolumne River, in the high Sierras, which involves the flooding of the Hetch Hetchy Valley, John R. Freeman has made a notable report in which he advocates plans for a higher dam at the Hetch Hetchy site than has previously been proposed, the early construction of the dam instead of postponing construction, and a greatly modified aqueduct plan from the source of supply to the San Francisco metropolitan water district. The aqueduct would in large part be a pressure tunnel, thus making possible immense hydro-electric developments, none of the power being required for pumping the water-supply, as under earlier plans. The report also deals with various objections raised by the opponents of the Hetch Hetchy plan, including the alleged destruction of a remarkable mountain meadow and the alleged necessary exclusion of campers and sight-seers from a considerable portion of the Yosemite National Park. Mr. Freeman shows that but few people ever visit the Hetch Hetchy Valley, largely because it is so inaccessible. He proposes that the city construct a good highway from the railroad to the proposed dam, and a scenic road around the reservoir. All the features just outlined are taken up in our abstract of Mr. Freeman's report. A remarkable set of comparative profiles of the earlier and Freeman aqueduct projects is reproduced and Mr. Freeman's cost estimates are reprinted.

Another stage in the struggle of San Francisco to secure a municipally owned water-supply was marked during the past summer when John R. Freeman, of Providence, R. I., reported on a water-supply for San Francisco and neighboring cities. The report* is one of those remarkably comprehensive reviews of the many engineering phases of a subject for which Mr. Freeman has become notable and presents cost estimates and illustrations with uncommon fullness of detail.†

The report is the result of an order served on the city of San Francisco by Ex-Secretary of the Interior Ballinger and modified by Secretary Fisher to show cause why a permit issued by Ex-Secretary Garfield granting the city certain rights on federal lands essential to building dams and a conduit to convey water from the upper portion of the Tuolumne River drainage area to the city of San Francisco should not be revoked. The permit was issued with the condition that the dams on Cherry Creek and at Lake Eleanor (See Fig. 2) should be built before the one across the Tuolumne River in the Hetch Hetchy Valley, which latter would flood a Sierra meadow (See Fig. 1) bounded on either side by precipitous cliffs. The original permit was vigorously fought by a group of men intent on preserving inviolate this natural scenery, which is within the large area embraced by the Yosemite National Park, but separated from the Yosemite Valley by some twenty miles of rough mountain country.

The city owns in fee simple most of the Hetch Hetchy Valley, which was purchased from early settlers and thus is not a part of the park; but one end of the dam site and much of the marginal flowage is a part of the National domain.

In granting the original permit Ex-Secretary Garfield made statements designed to show that the claims of San Francisco on the water from this drainage area, for municipal use, stood above all claims for conserving natural scenery. He maintained, or gave countenance to the city's claims, that the substitution of a mountain lake for a mountain meadow would go far toward making good the loss of the meadow, but met the demands of the Nature lovers in part by insisting on postponing the building of the Hetch Hetchy dam until the limit of the supply from Lake Eleanor had been reached.

In reopening the case there appeared, as advisers to the Secretary of the Interior, an Advisory Board of Army Engineers, consisting of Colonels Biddle, Cosby and Taylor, for it was found that the decision must rest on engineering considerations largely and that the decisions might turn on the relative advantages of other possible sources of supply.

At this time San Francisco was under the McCarthy Labor Union administration, and the City Engineer, Marsden Manson, was sadly hampered by lack of appropriations from making the extended investigations called for in the order to show cause, and finally after the reform administration of Mayor Rolph had taken office he broke down from nervous strain and past overwork. Meanwhile the time within which the city must make its reply, although extended, had nearly expired.

Mr. Freeman assembled a staff of engineers from the East and Far West to work under his immediate direction, utilized the services of a number of expert engineers in San Francisco, wove together old and new evidence, and filed the first installment of his report at midnight on the date fixed. This report included a summary of the main facts given in the numerous supplementary reports. In two weeks further time, granted by the board, the supplementary reports were completed, further digested, and the main report by Mr. Freeman continued and completed.*

Before taking up the Freeman report in detail it may be noted that the Hetch Hetchy supply was first proposed and outline plans for it prepared some ten years ago by C. E. Grunsky, then city engineer of San Francisco, and that the plans were subsequently revised, after further study by Marsden Manson, who was until quite recently city engineer. It may also be stated that within the past few years considerable progress has been made on a project for a metropolitan water district to include San Francisco, Oakland, and a number of other municipalities, and that legislative authority to that end has been secured and some steps taken toward organizing the district, so that it is now proposed to supply all of the twenty or more municipalities surrounding San Francisco Bay and double the population originally contemplated.

Briefly, Mr. Freeman proposes to build a higher dam and thus to form a larger reservoir in the Hetch Hetchy Valley than had been proposed by his predecessors. Moreover, Mr. Freeman proposes to utilize in early years the large surplus carrying capacity of the aqueduct for the irrigation of kitchen gardens and for intensive farming on some of the tens of thousands of acres of fertile lands along the bay south of San Francisco and south of Oakland, and believes that great suburban communities can be built up composed of homes each with an acre or half acre of garden attached in

*"On the Proposed Use of a Portion of the Hetch Hetchy, Eleanor and Cherry Valleys, within and near to the boundaries of the Stanislaus U. S. National Forest Reserve and the Yosemite National Park as Reservoirs for Impounding Tuolumne River Flood Waters and appurtenant works for the Water Supply of San Francisco, Calif., and Neighboring Cities. A Report to James Rolph, Jr., Mayor of San Francisco, and Percy V. Long, City Attorney, by John R. Freeman, Civil Engineer, of Providence, R. I., with Letter of Transmittal to the Honorable Secretary of the Interior and the Advisory Board of Army Engineers, San Francisco, July 15, 1912." [Supplementary reports and appendixes coming down to Aug. 1, 1912, make up an illustrated quarto volume of 401 pages.]

†Following our abstract of this report will be found a summary of a hearing on this subject held in Washington in November, 1912.—Ed.

*This stupendous task can be fully appreciated only by those who see and read the large volume which resulted. The task was performed under high pressure, working literally night and day, as the writer of these lines can attest from having visited Mr. Freeman's suite of rooms on the top floor of the St. Francis Hotel while the work was in full swing. There, desks, drafting tables and apparatus, reference books, maps, photographs, manuscript and printer's proof in all stages crowded the customary hotel furnishings into the background, illustrating that the engineer can adapt himself to all places and circumstances of work. His working day regularly began at 5 a.m. and continued until 10 or 11 p.m.

which the conditions for family life shall be at their best and from which future electric railways can quickly carry the breadwinners to the city. As at Los Angeles, about the same amount of water per acre will be needed here for intensive farming as for such suburban homes.

The engineering reasons for first building the high dam at Hetch Hetchy, in place of low ones at the other sites, are strikingly shown by the comparative profiles and other data, Fig. 3. Mr. Freeman's proposed Hetch Hetchy dam, shown by Fig. 4, would be about 300 ft. high and would store 110,000,000,000 gal. Thence an aqueduct, 124 miles long, comprising 77 miles of pressure tunnel 10 to 12.5 ft. in diameter and 45 miles of steel siphon across the San Joaquin Valley, runs to a terminal gatehouse near the southerly end of San Francisco Bay, from which gatehouse branch aqueducts would lead to San Francisco, Oakland, San Jose and other points. The main aqueduct would have a capacity of 400,000,000 gal. The San Francisco branch or continuation would have a capacity of 100,000,000 gal. at the outset and a length of 42.6 miles, thus making a total length of 166.7 miles. The Oakland branch would carry 50,000,000 gal. at the beginning and would be about 25 miles long.

A notable difference from former plans, all of which involved pumping and utilized all electric power developed solely for this pumping, is that Mr. Freeman brings water in by gravity and has power as a byproduct.

A total of 157,500 mechanical horsepower day and night the year around and possibly 200,000 hp. at peaks would be available were Mr. Freeman's plan fully carried out, little or nothing further being required than to insert power houses in the aqueduct line and build transmission lines.

A notable feature of the plan, designed particularly to meet the objections to substituting a mountain lake for a mountain meadow, is a scenic road around the Hetch Hetchy Reservoir and to neighboring view points. Another feature is a good automobile road to the Valley, which is now accessible only with difficulty, over a rough trail.

FIG. 1. A PORTION OF THE SITE OF THE PROPOSED HETCH HETCHY RESERVOIR, FOR THE WATER-SUPPLY OF SAN FRANCISCO

(The view shows the depth to be flooded in relation to the height of the cliffs. It also shows the location of the scenic road proposed by John R. Freeman, which would run along a broad bench, covered with stunted trees, located 200 or 300 ft. above the high-water line.)

It is assumed that San Francisco will buy the works of the Spring Valley Water Co., which now supplies water to the city, and for which an informal offer of $38,500,000 has already been made, and that the new Hetch Hetchy supply would be conveyed to the existing reservoirs of this company and of the companies which supply Oakland and vicinity. Portions of the supplementary reports (which lack of space prevents summarizing here) deal with these interconnections, with enlargements of existing reservoirs, and with the available yields of the various sources of supply of the Spring Valley Water Co. Mr. Freeman believes that these possible additional yields from the several sources controlled by these companies have been overestimated, and that although the city buys the Spring Valley works it should proceed immediately with the Hetch Hetchy scheme. He presents estimates of the cost of supplies from a number of other sources than the Hetch Hetchy, including both high mountain streams and the Sacramento River, the latter filtered and pumped. None of these, Mr. Freeman believes, compare at all favorably with the plan already sketched. Indeed, it is stated that to deny the use of the Hetch Hetchy would add from 10 to 30 million dollars to the cost of an adequate future supply.

Having outlined the causes which led to the making of the Freeman report and having briefly summarized the leading features of the proposed plan for a water-supply for San Francisco and vicinity, some condensed extracts from the report will next be given.

EXTRACTS FROM THE FREEMAN REPORT

The Hetch Hetchy Dam—The City of San Francisco proposes:

To build a masonry reservoir dam [Fig. 4] about 300 ft. in height above the bed of the river, in the narrow gorge at the outlet of the Hetch Hetchy Valley, by which the water can be raised about 270 ft. above the nearly level floor of the valley; said dam to have its outlets at such height that the water upstream cannot possibly be drawn so low as to uncover the level floor of the valley, which will thus always be covered by a broad, long lake. The shores of the lake will be very steep and largely composed of bare ledges. The lowest draft of the lake will not occur until after midwinter, and it will be replenished by the melting snows early in the spring. Seldom will the lake be less than three-quarters full on Oct. 1, and it will never be drawn within 20 ft. of the bottom, save in one of the greatest droughts of the century.

The Hetch Hetchy Aqueduct—The city proposes to build an aqueduct [see lower profile, Fig. 5] from the Hetch Hetchy Valley to the city of San Francisco largely in the form of a tunnel about 10 ft. in finished diameter, mostly deep beneath the surface of the ground, and from 10 to 50 ft. below the hydraulic grade line along the approximate route and at approximately the elevation shown in the accompanying plans and profiles, extending downstream from the proposed reservoir and dam to the easterly edge of the San Joaquin Valley. Thence continuing westward across this valley the projected aqueduct will be composed first of one steel pipe, 7 ft. 6 in. net diameter, and ultimately of two steel pipes side by side, each about 45 miles in length. At the westerly side of the San Joaquin Valley the steel-pipe portion is to end at a point about eight miles westerly from the confluence of the Stanislaus with the San Joaquin River. From this point the

aqueduct line proceeds easterly, mostly in the form of a series of tunnels about 12 or 13 ft. in diameter, to a point easterly from the village of Irvington, and about one mile northerly from Mission San Jose, on the hillside overlooking the southerly end of San Francisco Bay; at

FIG. 2. SKETCH MAP SHOWING THE DRAINAGE AREAS OF THE PROPOSED HETCH HETCHY, LAKE ELEANOR AND CHERRY CREEK RESERVOIRS

which point a terminal chamber and gatehouse would be built and branch aqueducts lead off as desired toward Oakland, San Jose, San Francisco and various other communities about the bay.

From this "Irvington gatehouse" the aqueduct would proceed westerly in the form of a steel pipe, supported above the water on concrete piers, on a line parallel to the present railroad bridge, but submerged at the ship channel across the Dumbarton Narrows, near the head of San Francisco Bay (or could be carried on dry ground around the head of the bay), to a point of suitable elevation, whence it could discharge by gravity flow at an elevation of 320 ft. above the mean sea level.

The proposed aqueduct between the Hetch Hetchy and the Irvington gatehouse on the hillside overlooking San Francisco Bay is designed to deliver by force of gravity without pumping, a quantity somewhat in excess of 400 million gallons daily (equivalent to 620 cu.ft. per sec.), and under extreme conditions possibly 500 million gallons daily. All of the tunnels will from the first be built to their full ultimate size and smoothly lined with concrete so as to have this capacity, plus some reasonable excess for emergencies, and the steel-pipe siphon at the Tuolumne crossing will be 10 ft. net diameter, giving the same capacity as the tunnels. At first and until the second steel pipe is built across the great San Joaquin Valley the capacity will be 240,000,000 gal. daily.

When the second pipe across the San Joaquin Valley is added, 400 million gallons daily can be conveyed from Hetch Hetchy to the gatehouse, near Irvington, where it will be subdivided among the different communities contributing to its cost. The branch line of steel pipe to be taken across to supply the cities and valleys of the San Francisco Peninsula will have a capacity of about 100 million gallons per 24 hours.

All of the tunnels are to be smoothly lined with portland-cement concrete, and it is proposed to smoothly line with portland-cement mortar all of these steel pipes, in order to preserve the steel from rust and to maintain the carrying capacity undiminished, thus practically the aqueduct all the way from the Sierras to the street water mains of San Francisco and Oakland will have an interior like a pipe of stone.

The communities to be immediately supplied require for domestic and municipal purposes less than one-half of the amount that the single pipe will bring, but since the surplus will flow without cost of pumping, it is proposed to bring all of the water that the one San Joaquin pipe will carry to the Irvington gatehouse and make the surplus available, at a moderate meter rental, for irrigation, principally for intensive farming and truck gardens, almost anywhere around the agricultural lands bordering San Francisco Bay; very much as it is proposed to use the surplus capacity of the Los Angeles aqueduct; all of this use tending to the prosperity of those districts and tending to a cheapening of the food supply of Greater San Francisco, but with care to so frame the leases for this secondary water-supply that it may forever remain available when needed for the higher purpose of domestic supply.

The Early Intake—The portion of the tunnel about 12 miles in length next downstream from the Hetch Hetchy dam would be delayed in construction for some years, and meanwhile the city proposes to divert the water from the main Tuolumne River by means of a temporary dam across it at a point about one and a half miles upstream from the confluence of Cherry Creek.

Eleanor-Cherry Aqueduct—Also the city proposes in the more or less distant future to build a tunnel about 8 ft. net diameter, deep underground, from a point near to and above the proposed Hetch Hetchy dam, over a northwesterly course to the reservoir site which the city owns on Cherry Creek, this tunnel to pass directly beneath the Lake Eleanor reservoir site, also owned by the city, with appropriate gatehouses and intake shafts at Cherry and Eleanor for diverting their waters into the said 8-ft. tunnel and thence into the Hetch Hetchy Reservoir, for aid in replenishing it when the demand upon the city's source becomes large.

Eleanor and Cherry Temporary Dams—The city proposes to build small, cheap dams at first for both the Eleanor and Cherry reservoirs [see map, Fig. 2], each at a site some distance upstream from the permanent damsite. These temporary dams, which may serve acceptably for 25 or 50 years, being mainly for diverting the waters into the steep tunnel to Hetch Hetchy already described, and to store for a few days the peaks of floods until the tunnel can take in the water which will be stored in Hetch Hetchy. Some storage will be retained in these reservoirs most of the year.

Eleanor and Cherry High Dams—The

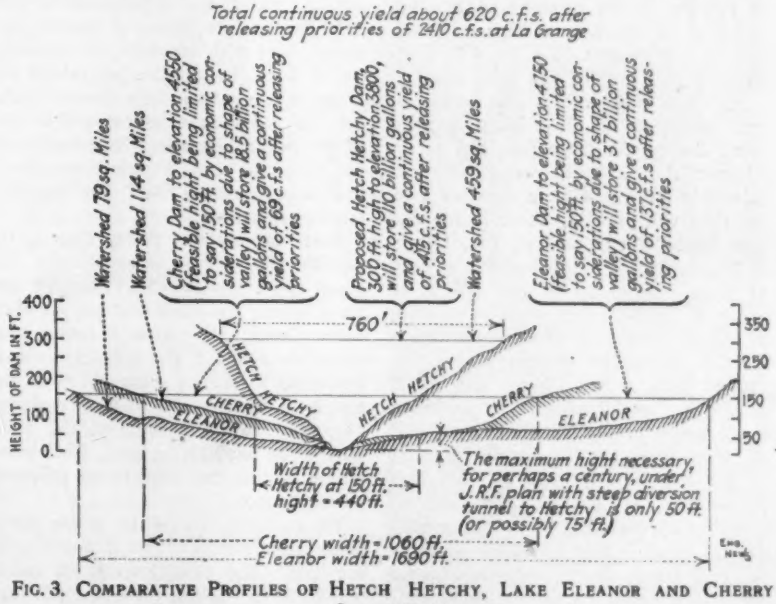

Total continuous yield about 620 c.f.s. after releasing priorities of 2410 c.f.s. at La Grange
Watershed 79 sq. Miles
Watershed 114 sq. Miles
Cherry Dam to elevation 4550 (feasible hight being limited to say 150 ft. by economic considerations due to shape of valley) will store 18.5 billion gallons and give a continuous yield of 69 c.f.s after releasing priorities
Proposed Hetch Hetchy Dam, 300 ft. high to elevation 3800, will store 110 billion gallons and give a continuous yield of 415 c.f.s. after reledsing priorities
Watershed 459 sq. Miles
Eleanor Dam to elevation 4150 (feasible hight being limited to say 150 ft. by economic considerations due to shape of valley) will store 37 billion gallons and give a continuous yield of 137 c.f.s after releasing priorities
760'
HETCH HETCHY
CHERRY
ELEANOR
HEIGHT OF DAM IN FT.
400
300
200
100
0
350
250
150
50
Width of Hetch Hetchy at 150 ft. hight = 440 ft.
The maximum hight necessary, for perhaps a century, under J.R.F. plan with steep diversion tunnel to Hetchy is only 50 ft. (or possibly 75 ft.)
Cherry width = 1060 ft.
Eleanor width = 1690 ft.
ENG. NEWS

FIG. 3. COMPARATIVE PROFILES OF HETCH HETCHY, LAKE ELEANOR AND CHERRY CREEK DAMS

(Mr. Freeman states: "Hetchy, by far the largest watershed, has much the shortest dam.")

city proposes at some future time, perhaps fifty or more years hence, when the demand for water becomes still greater, to replace these low temporary dams on Eleanor and Cherry Creek by high masonry dams of the most permanent and perfect character at the damsites already selected and surveyed at the outlets of Eleanor and Cherry creeks. There is an excellent granite foundation for a high dam at each of these sites, but at both the Eleanor and Cherry sites the great length of dam required for crossing the comparatively broad valley bottom and the great cost of transporting cement into this rough distant country and high altitude, across the Tuolumne gorge from the main highways, compels deferring the building of large dams here until the latest practicable date.

The broad area of Lake Eleanor presents a very capacious storage for a given increase in height, but its catchment area is only about one-sixth part of that tributary to the Hetch Hetchy Reservoir [see Fig. 2]; moreover, this Eleanor catchment area is at an altitude where the average snowfall is smaller and is melted earlier in the spring.

At the Cherry reservoir also the catchment area is small, being only one-fourth of that tributary to the Hetch Hetchy [see Fig. 2]. Moreover, the storage capacity in its reservoir is particularly small in relation to the quantity of masonry required in building a high and substantial gravity dam. [See Fig. 4 for comparative dam profiles and other data].

Although these unfavorable conditions are presented at the Cherry damsite, small storage for large cost, and at the Eleanor site, a small watershed, with relatively large cost for a masonry dam, the time will probably come in the distant future when dams of, say, 150 ft. in height, will be worth building at each of these two sites. A dam 150 ft. in height at Lake Eleanor would store about 37 billion gallons of water, according to the City Engineer's surveys; and a dam 150 ft. high at the Cherry site would store about 18 billion gallons, according to the report of William Hammond Hall. At both sites the inaccessibility adds to the cost of any type of high dam proper for the location. The impracticability of planning an arched gravity dam of small radius for either of these two sites makes ample thickness of great importance under the severe winter conditions that may be found at this altitude.

Notwithstanding these disadvantages in cost and capacity, the city desires to preserve all its rights to the highest practicable dam at each site and to the storage of all of the tributary waters at each site which now remain unappropriated.

Other Reservoirs in Distant Future—In the very distant future it may also become desirable to build supplementary reservoirs for the further storage and conservation of flood waters for the use of the city as a reserve against years of uncommonly low rainfall, these to be located upon Vernon Lake and other sites upstream therefrom, upstream from Rancheria Falls, and upstream from the Lake Eleanor and Cherry reservoirs. The city therefore desires that all permits for reservoir building on the public lands upstream from the Hetch Hetchy, Lake Eleanor and Cherry reservoir sites be reserved in favor of the municipalities of Greater San Francisco.

Eleanor and Cherry Wagon Roads—The city proposes to construct in the near future a good wagon road both to the Eleanor and the Cherry damsite from the Hetch Hetchy dam, and the city may find it expedient to build these roads long before the above described Cherry and Eleanor tunnels and dams are built. There is no wagon road whatever into these regions at present; only rough mountain trails.

Power Development—The city does not propose in the immediate future to build any plant for the development of hydro-electric power, but it plans to carefully conserve all reasonable opportunities for power development against the time when it may become expedient for the city to undertake such matters, and the aqueduct will be built with surge shafts, inclined tunnels and appurtenances suitable for the attachment of turbine penstocks, and with forebays for receiving water from the tailrace of future turbines, so that substantially the only added cost for power development will be that of the power house and its foundations, the hydraulic and electrical machinery and appurtenances, and the electrical transmission lines.

There is only one power drop in the aqueduct line first to be constructed. The power-house site for this is located very close beside the main highway at Moccasin Creek, six miles easterly from where the aqueduct line crosses the main Tuolumne River, and about 141 miles distant from the City Hall of San Francisco, along the aqueduct line, or 150 miles around the head of the bay. [See lower profile, Fig. 5, for location of proposed power houses.]

The elevation of tailwater at this power house is planned to be 890 ft. above mean sea level. The water level at the intake will be 2315 ft., and the gross fall thus 1425 ft.

Under working conditions, the head of the flowing water in the surge shaft at the top of the incline tunnel will be about 2150 ft. above sea level, giving a net working fall of approximately 1250 ft. when 620 sec. ft. are flowing. With waterwheels of ordinarily good design and efficiency this head and volume will produce 70,000 mechanical horsepower 24 hours per day, under conditions exceptional for efficiency and low cost of operation.

Whenever the upstream twelve miles of aqueduct is completed between the Hetch Hetchy dam and the Early Intake, another power drop will become available immediately in the rear of the Early Intake, about a mile upstream from Cherry Creek, with the same 620 sec. ft. of water already mentioned.

The gross fall here will be 1425 ft., and the net under extreme conditions 1325 ft., giving 75,000 mechanical horsepower, 24 hours per day and 7 days in the week.

The city also proposes at some distant future time to construct a short, steep auxiliary tunnel and surge shaft at the downstream end of the Hetchy-Cherry-Eleanor tunnel by which the Cherry-Eleanor water, instead of falling into the Hetch Hetchy Lake, can be diverted underground to a small hydro-electric power house, to be constructed near the base of the Hetch Hetchy dam, with an electrical transmission line leading off thence toward the city, along the new roadway already described.

From the Cherry-Eleanor conduit with the low dams there could not be so much power developed in the early years as after the regulation of their flow by the future high dams, because in the earlier years their spring floods will be discharged with a rush, through the steeply inclined tunnel into Hetch Hetchy. Still, it would be worth saving, by a plant designed more particularly for future conditions. This power would have a special value for supplementing the other power at times of peak loads without sacrifice of water, by discharging into Hetch Hetchy Lake instead of into the aqueduct. At some distant future day this Cherry and Eleanor power will become valuable. Its ultimate amount may be reckoned as roughly equivalent to an average flow of 175 sec. ft., although its rate of delivery would be irregular and chiefly useful at peaks in supplementing the other power plants.

From this quantity of water under a power drop from Eleanor, or Cherry, to Hetch Hetchy averaging about 800 ft. net fall, there could be generated ar average of 12,500 hp. of mechanical power. In the early years, with the small storage and the rapid drawing through the tunnel for replenishing Hetch Hetchy, less power could be conserved.

Adding up the power at these three sites we would have ultimately a total of 157,500 mechanical horsepower available 24 hours per day and 365 days in the year; supplying possibly 200,000 hp. at peaks, under ordinary practical conditions.

At all three sites the cost of power house and that of the hydro-electrical machinery will be exceptionally small and the flow of water uncommonly constant and dependable. On the other hand, the

transmission line, although laid mostly over the aqueduct rights-of-way, would be 150 miles long to San Francisco and 135 miles to Oakland, and cost a large amount of money.

energy would add to the prosperity of Greater San Francisco. As the city grows and increases its municipal activities, its own demands for electric current, for lighting and for power may become large

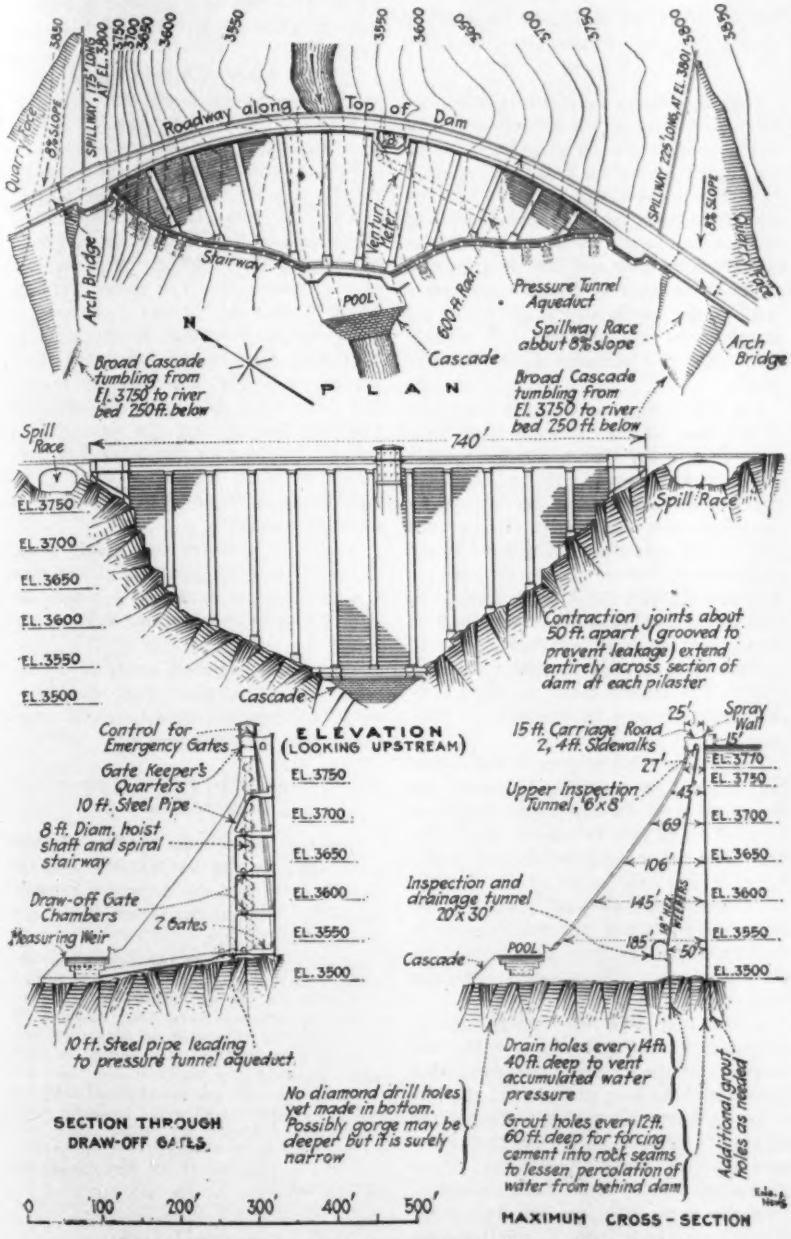

Roadway along Top of Dam
Quarry face
Spillway, 175' long at El. 3800
Spillway 225' long at El. 3801
Arch Bridge
Stairway
Venturi Meter
POOL
600 ft. Rad.
Pressure Tunnel Aqueduct
Spillway Race about 8% slope
Cascade
Broad Cascade tumbling from El. 3750 to river bed 250 ft. below
PLAN
740'
Spill Race
EL. 3750
EL. 3700
EL. 3650
EL. 3600
EL. 3550
EL. 3500
Contraction joints about 50 ft. apart (grooved to prevent leakage) extend entirely across section of dam at each pilaster
ELEVATION (LOOKING UPSTREAM)
Control for Emergency Gates
Gate Keeper's Quarters
10 ft. Steel Pipe
8 ft. Diam. hoist shaft and spiral stairway
Draw-off Gate Chambers
2 Gates
Measuring Weir
15 ft. Carriage Road 2, 4 ft. Sidewalks
Spray Wall
Upper Inspection Tunnel, 6 x 8
Inspection and drainage tunnel 20 x 30'
10 ft. Steel pipe leading to pressure tunnel aqueduct
SECTION THROUGH DRAW-OFF GATES
No diamond drill holes yet made in bottom. Possibly gorge may be deeper but it is surely narrow
Drain holes every 14 ft. 40 ft. deep to vent accumulated water pressure
Grout holes every 12 ft. 60 ft. deep for forcing cement into rock seams to lessen percolation of water from behind dam
Additional grout holes as needed
MAXIMUM CROSS-SECTION
0 100' 200' 300' 400' 500'

FIG. 4. THE FREEMAN DESIGN FOR THE HETCH HETCHY DAM

(The probable quantities are: Concrete, 372,000 sq.yd., of which 200,000 would be in the main body of the dam and 172,000 a richer face mixture; base area to be cleared to sound rock, 100,000 sq.ft. Rock excavation for spillway races, 133,000 cu.yd.)

The time will surely come when this power privilege will be a most valuable asset of the Tuolumne water-supply system.

There will doubtless be a limit to the era of oil at present prices and year by year new electro-chemical manufacturing processes are being discovered, in some of which an abundant supply of electrical enough to warrant the large cost of a transmission line 150 miles long.

Sanitary Control—As to sanitary restrictions, the city proposes nothing beyond those now acceptable the world over, as properly safeguarding the great storage reservoirs for municipal domestic supply, such for example, as those today in force around the impounding reservoirs of Boston, New York, and many other cities which maintain most scrupulous health bureaus and which do not filter their water.

As a result of repeated exhaustive scientific investigations of the foremost health authorities in the United States, Germany and England, it has been proved beyond the shadow of a doubt that long storage in reservoirs is one of the greatest of sanitary safeguards to a drinking-water supply, and that it is standing water rather than running water which purifies itself. Stated in plain, common-sense terms, the reason is, that in the course of a month or two at the most, any pathogenic germs die under this unfavorable environment.

In the present case, with a cold mountain water coming chiefly from melting snows, running over granite steeps, in a region so sterile and so cold and at such an altitude that man is absent half the year and never present in a number statistically large when expressed in the ordinary sanitary terms of number of inhabitants per square mile; the possible dangers and the sanitary restrictions necessary will both be less than in the case of distributing reservoirs within populous communities like those of Boston and New York.

The sanitary control and tendency to exclusion of the people from the region upstream from the Hetch Hetchy might properly be much less severe than for the ordinary impounding reservoir, instead of leading to such absurd restrictions as some who in the past have opposed the use of this valley for a reservoir site have, in their excited state of mind, claimed would be enforced.

Any statement that the use of the Hetch Hetchy for domestic water-supply storage would probably cause the exclusion of tourists and campers from the watershed tributary thereto is utterly without foundation and those who suggest it set up a fanciful standard of their own for San Francisco, far more rigorous than is found needful by sanitary science or called for by experience in the study of water-borne disease.

[In place of "Sanitary Rules," which appeared at this point in the report, there are given near the close of the article similar rules as suggested at the hearing in Washington in November, 1912—ED.]

Fishing and Camping—Fishing along the tributary streams or in the upstream part of these reservoirs need not be prevented, and camping at any point more than a mile upstream from the head of the reservoir can do no possible harm.

The ordinary proprieties which any decent man would regard, knowing that these waters were to be used for domestic supply, are all-sufficient and all necessary supervision could be readily enforced by a single park policeman, on duty one-third of the year, and by the

posting of notices at intervals along the shore in the frequented places, just as is done on the shores of the Spot Pond reservoir of Boston and around the margins of Boston's Chestnut Hill reservoir.

While reaching a decision as to what regulations would be proper and reasonable for the Hetch Hetchy, it is instructive to study various notable precedents. A number of pages of text and illustrations are devoted to examples of the shores of various water-works reservoirs for recreation, including reservoirs forming parts of the water-supplies of Boston, New York, Birmingham, Manchester and Glasgow.

At this point Mr. Freeman presents data designed to show that the use of the Hetch Hetchy site will preserve other possible camping sites, since it will store so large a proportion of the flood waters as to lessen the need or make unnecessary storage elsewhere—which storage would certainly be sought in behalf of of other interests if not assigned to the municipal use of San Francisco.

Comparisons of Freeman Plan with Earlier Grunsky and Manson Plans

As Mr. Freeman points out in his report, the growth of San Francisco since the first or Grunsky plan of 1902, combined with the recent proposition for a metropolitan water district and with various other new factors, all unite to call for a different water-supply scheme in 1912. One of the new factors is the adoption of pressure tunnels instead of strictly gravity aqueducts for the new water-supplies of New York and Los Angeles. Confidence gained by the experience of these two cities (though the aqueduct of neither is yet in use) gave warrant for the incorporation of pressure tunnels in the new San Francisco plan, with marked savings in distance and great increases in power available, besides making it more feasible to do away with the considerable mileage of open canals in the Grunsky and the Manson plans. The earlier plans provided for only some 60,000,000 gal. a day at the start, as against 240,000,000 gal. in the later Freeman plans, and an ultimate supply of 400,000,000 gal. As Mr. Freeman stated, tunnels of the smaller capacity cost relatively little more than those of the larger capacity, "minimum size and cost for a long aqueduct" being determined by room for railroad track and space for workmen, not by the volume of water, 180,000,000 gal. The cost of the first installment under the Freeman plan is estimated at about $37,000,000 as compared with $31,000,000 for the Grunsky plan, which would have afforded relatively little power and would have used all that to pump the small amount of water over ridges which are avoided by the Freeman location and pressure tunnels.

Those interested in further comparisons of the earlier and the Freeman plans will find an abundance of detail in small space in the profiles which comprise Fig. 5.—Ed.]

The Few Visitors to Hetch Hetchy; A Further Extract from the Freeman Report

Notwithstanding the Hetch Hetchy Valley has for some years past been one of the best advertised pleasure spots in the United States, by reason of appeals published by the Sierra Club and by various gifted writers, and notwithstanding the fact that during the month of September, after the mosquito pest is over, this valley is veritably a "paradise for campers," very few campers go there for pleasure and the number from outside the State of California is particularly small.

The few soldiers who act as guardians of this part of the National Park keep a record of every visitor, whether tourist, cattleman or surveyor. In the year 1909, the Sierra Club widely advertised an excursion into the Hetch Hetchy, but even in that year and including the Sierra Club, which has a membership widely scattered through the United States, the total number of visitors from June to September inclusive, included only 17 persons from outside the State of California, and among these 17 were only four whose homes were east from Chicago.

The total number of visitors listed during the season of 1909, including the forest rangers, the surveyors employed by the City of San Francisco, the cattlemen from adjoining counties, and counting over and over again in the number of visitors the repeated visits of the city's surveyors and packers bringing in food supplies to the surveyors, aggregated only 269 persons for the year.

In the year 1908 the official lists of visitors to the valley on file with the Department of the Interior shows the first entry about the first of June and the last entry on Sept. 30, and the records for the entire season show that only two persons from outside California visited the valley, both of these from Kansas.

In the year 1910, the list begins on May 27 and ends Oct. 3, and includes only 16 persons from outside California, five of whom were from New York, one party of four from Philadelphia, one from Boston, and one, myself, from Providence.

In the year 1911, the season opened late, owing to heavy snows and swollen streams. The Army Board of Advisory Engineers and the City Engineer's party were among the earliest visitors and found mosquitoes too plentiful in the meadows to encourage early arrival. The first entry is July 10, and the 1911 list shows many more visitors from outside the state than before, mainly because of largely attended excursion of the Sierra Club on July 30, which came in 185 strong, of whom 37 were from outside California and 148 were Californians, 20 from San Francisco.

[We are informed by Mr. Freeman that in 1912 the record shows only two from outside California up to Aug. 14. These were guests of Californians.—Ed.]

Year by year the records show that by far the greater number of the visitors listed either came from the cities about San Francisco Bay or from the neighboring agricultural districts near the foot of the mountains. The reason for this small number of visitors from outside the state becomes plain to one after he has made the trip and found out about the inaccessibility, the hardship to one not accustomed to the saddle, and the expense; and if one has happened to time his camping on the valley floor during the mosquito season he cannot truthfully describe that part of the trip as a pleasure excursion.

A pair of campers can hardly make the trip if bent on pleasure, in less than a week's time nor can they readily do it for a smaller expense than $200 for the party.

What one finds there today is beautiful, but it is relatively tame and uninteresting in comparison with the far more grand and varied Yosemite.

Summary of Cost of Proposed Hetch Hetchy Supply

[For the better understanding of what is included in the $37,000,000 estimate already mentioned the following extracts from Mr. Freeman's report are here given.—Ed.]

It is estimated that the cost of developing this system step by step as above described will be as follows:

These estimates have been made with a painstaking attention to detail seldom attempted in preliminary work of this character and the figures are also set forth open to the examination of citizens and the promoters of rival projects with uncommon fullness in order that the matter may be fully discussed and every part of the data for these cost estimates made plain.

In reviewing the costs for the various divisions it should be clearly kept in mind that several of those divisions set forth alternative projects, only one of which would be adopted and in order that the structural advantages of the more expensive types of aqueduct may be properly balanced against the economics of cheaper types.

The following are estimated costs of the several portions of the work, arranged in order of date and of proximity to the city, although work will be going on simultaneously in many places all along the line.

The following figures include contractor's profit, headquarters expense, interest during construction, etc., which see for details and basis.

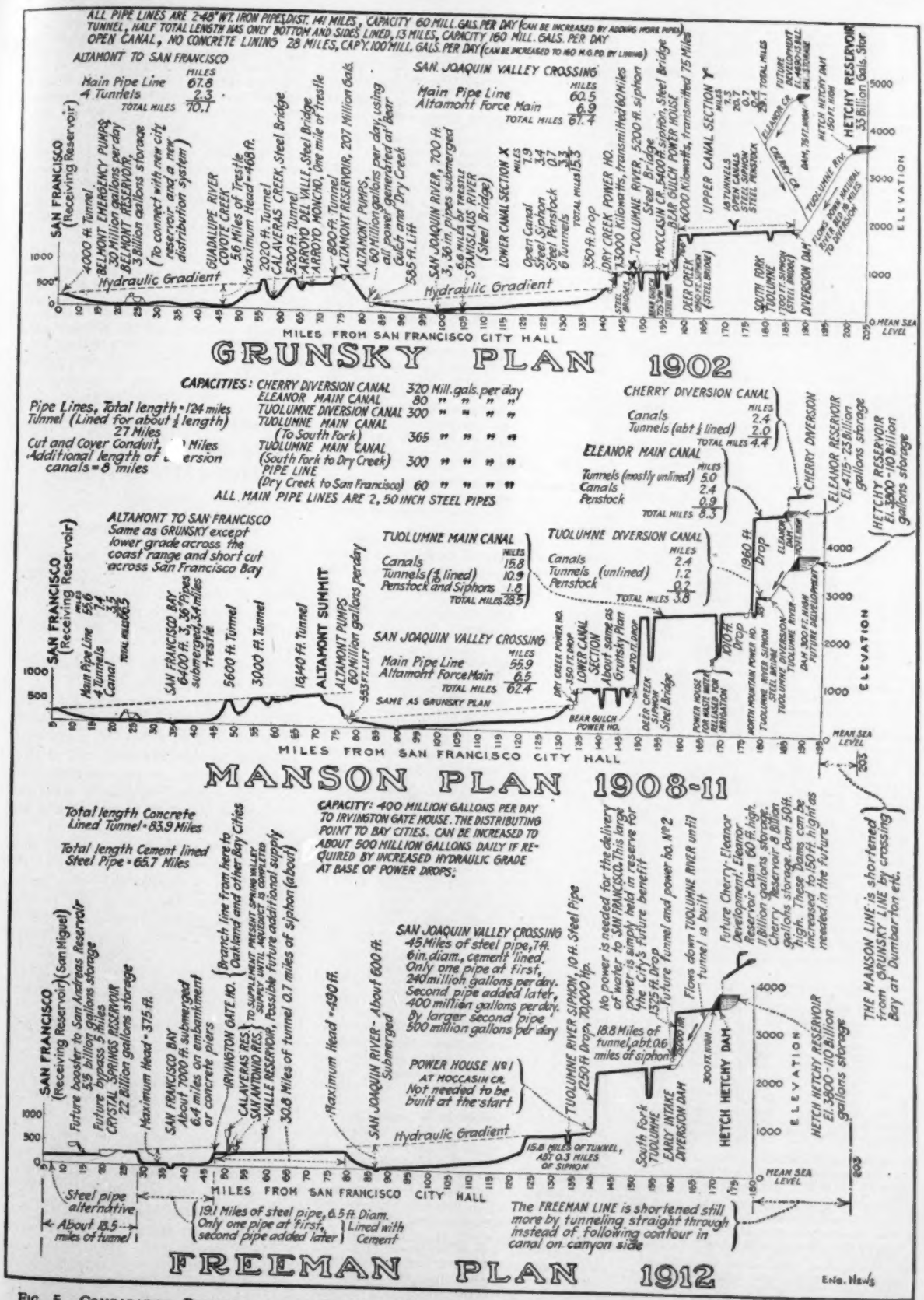

GRUNSKY PLAN 1902
MANSON PLAN 1908-11
FREEMAN PLAN 1912
MILES FROM SAN FRANCISCO CITY HALL
ELEVATION
SAN FRANCISCO (Receiving Reservoir)
HETCHY RESERVOIR
ALTAMONT TO SAN FRANCISCO
SAN JOAQUIN VALLEY CROSSING
CHERRY DIVERSION CANAL
ELEANOR MAIN CANAL
TUOLUMNE MAIN CANAL
TUOLUMNE DIVERSION CANAL
Hydraulic Gradient
ALL MAIN PIPE LINES ARE 2.50 INCH STEEL PIPES
SAME AS GRUNSKY PLAN
Steel pipe alternative
About 18.5 miles of tunnel
THE MANSON LINE is shortened from GRUNSKY LINE by crossing Bay at Dumbarton etc.
The FREEMAN LINE is shortened still more by tunneling straight through instead of following contour in canal on canyon side

FIG. 5. COMPARATIVE PROFILES OF THE PROPOSED SAN FRANCISCO AQUEDUCT, GRUNSKY, MANSON AND FREEMAN PLANS

(a) Steel pipe 4.5 ft. net diameter, 24.3 miles long, capacity about 50 million daily varying according to slope, from San Miguel Reservoir or University Mound Reservoir to the Redwood City manifold gate house, estimated cost.. $1,861,000

(b) From Redwood City manifold gate house to Irvington gate house, cement lined steel pipe net diameter 6.5 ft., capacity 100 million gallons daily with slope of 0.85 ft. per 1,000, or 4.5 ft. per mile, built across the flooded marsh lands either on concrete piers or upon an earth embankment, as may prove most expedient on further study and for the mile of crossing at the head of the harbor to be either submerged in a dredged chanel or to be carried on concrete piers above the water level not far from the present line of the railroad trestle to a short submerged section corresponding in location to the railroad drawbridge, total length 16.7 miles, estimated cost..... 2,682,000

(c) Branch line steel pipe 4.5 ft. diameter from Redwood manifold gate house into the head of Crystal Springs Reservoir, about 3.6 miles in length, capacity 50 million gallons daily, under 7.0 ft. slope per mile, variable to meet conditions, estimated cost..... 434,000

(d) From Irvington gate house, 3.2 miles of tunnel 12.8 ft. diameter (400 to 500 million gallons daily capacity) under mountain at Mission San Jose to Calaveras Junction in the Sunol Valley.... 1,133,000

(e) Calaveras Junction across Sunol Valley, 0.85 miles of cement lined steel pipe siphon 8.75 ft. net diameter, cost.. 122,000

(f) From Sunol Valley to Tesla Portal, 27.5 miles in length, 12.8 ft. diameter, future capacity 400 to 500 million gallons daily, cost..... 10,262,000

(g) Cement lined steel pipe. 7.5 ft. net diameter, from Tesla Portal to the San Joaquin River crossing, 8.3 miles, capacity 240 million gallons daily with 10 ft. slope per 1,000..... 1,211,000

(h) 36.6 miles of cement lined steel pipe crossing San Joaquin River to tunnel portal southeast from Oakdale, 7.5 ft. net diameter, capacity, 240 million gallons daily, under 10 ft. drop per mile, cost..... 6,291,000

(i) Tunneling from San Joaquin Valley to Toulumne crossing at Red Mountain Bar, 10.25 miles, 12.8 ft. diameter, capacity 400 to 500 million gallons daily.. 3,168,000

(j) Toulumne River crossing. Steel pipe siphon, cement fined, 10 ft. net diameter, 0.4 miles in length with support.. 182,000

The pump lift from river into tunnel portal here would be 285 ft., but the river is polluted by mine waste from Wood Creek.

(k) Tunnel 10 ft. diameter, concrete lined, capacity 400 to 500 million gallons daily, 5.55 miles in length, Red Mountain Bar to Moccasin Creek power site..... 1,463,000

Sub-total from Moccasin Creek power site to the reservoir in San Francisco..... $28,809,000

(l) At this point the supply could be temporarily taken from river in case of emergency and delivered into Crystal Springs Reservoir by means of a cheap type of cut and cover conduit 50 million gallons daily capacity, from Moccasin Creek power site to a point on the Tuolumne River near Wards Ferry, 7.8 miles long. The probable cost, including low diversion dam, is estimated at about..... $275,000

A temporary open unlined canal for same distance could be built for less.

(m) Tunnel from Moccasin Creek to the Early Intake, 10 ft. in diameter, all concrete lined, including works at Early Intake and chute at Moccasin Creek, total length 19.5 miles, capacity 400 to 500 million gallons daily, under slope of 8 to 10 ft. per mile, cost..... 5,404,000

(n) Estimated cost of low Hetch Hetchy Dam, storing 40 billion gallons, including preparation of reservoir. Dependable yield after satisfying all irrigation priorities 160 million gallons daily..... 1,138,000

(o) Cost of easy-grade highway, temporarily occupied by railroad from Roasasco to the Hetch Hetchy Dam, 62 miles..... 1,288,000

(p) Roads to tunnel shafts on Coast Range divisions, additional..... 36,000

(q) First installment scenic road in Hetch Hetchy Valley, about 10 miles in length, comprising road on north side of valley to point opposite confluence of Tiltill Creek and on south side of valley upstream to the head of flowage; also easy-grade wagon roads to Lake Eleanor and Cherry Creek, laid out with a view to scenic advantages..... 300,000

Total cost of supply, varying from maximum of 240 million gallons daily to minimum of 100 million gallons daily in extreme drought, delivered to Irvington gate house overlooking San Francisco Bay, with 50 millions delivered into San Francisco 3 miles from City Hall, and 50 millions into Crystal Springs Reservoir when desired..... $36,981,000

And also with 60 million gallons daily ready for Oakland, San Jose, etc.

(r) Cement lined steel pipe 4.5 ft. in diameter from Irvington gate house delivering 50 million gallons daily as far as the City Hall, Oakland..... 2,247,000

The above 160,000,000 gal. daily would serve all needs and growth for the communities on both sides of San Francisco Bay for a long time and also provide water enough for San José, San Mateo, etc.

[Mr. Freeman writes us as follows: Instead of 160,000,000 gal. in extremely dry years, the dependable supply may be cheaply increased to upward of 240,000,000 gal.—the full capacity of the San Joaquin Siphon by increase in height of the storage dams.—Ed.]

The remarkable fact appears that the estimated cost of the Freeman project bringing a minimum supply of 160,000,000 gal. daily, to 240,000,000, including scenic road, and permanent highways, and with opportunity conserved for a future vast power development, costs less than any of the 60,000,000 gal. daily plans heretofore proposed, and moreover, avoids all the expensive upkeep of pumping stations.

It is this fact that has prompted a careful review of the figures and setting them forth in detail for examination by other engineers.

Future successive steps for increase of quantity to a dependable minimum of 240 million gallons daily—

(s) Unlined tunnel in granite, 8 ft. diameter, from Hetch Hetchy Reservoir to Eleanor and Cherry reservoirs..... 1,144,000

(The above diversion may properly precede the building of large dams and can be effected by small earth and rock fill dams giving only 10 or 15 ft. head, very cheaply built.)

(t) Earth dams storing about 50 ft. depth of water at Lake Eleanor and Cherry Creeks, exclusive of cost of water rights already paid for..... $1,170,000

(u) Low masonry dam for flooding Peopenaut Meadows and giving additional storage to elevation..... $98,000

The above works will give a dependable supply of 240 million gallons daily delivered to Irvington gate house in dryest years and comprise all of the water-supply works needed for the next 30 to 40 years, after which higher dams would be needed; also a second steel pipe across the San Joaquin Valley, with which pipe added 400 million gallons daily could be delivered on the shores of San Francisco Bay.

Expenditures already made by City of San Francisco for lands and water rights Hetch Hetchy, Eleanor, Cherry reservoirs. $1,236,000

The value of the opportunity for future power development will far more than provide for the extension of tunnel from Early Intake to the Hetch Hetchy Reservoir and for the extension of dams and further development of storage as needed to the full amount of 400 or 500 million gallons daily.

In reading preliminary estimates for this class of work I have sometimes found it hard to make certain that the unit costs for tunnels and aqueducts, at so much per lineal foot, had been properly loaded with various items of general expense which seldom are reckoned into the monthly estimates made in the field while the work is in progress and which partial cost often becomes quoted as the cost of the work.

In order to make plain the extent to which the estimates presented in this report have been loaded and to make plain the total cost per lineal foot at which my pipe and tunnel lines have been estimated. I have had the following table prepared, in which the field construction cost is given in the first line and the total cost per lineal foot in the last line, with the various accretions from loading and overhead charges noted in between [table omitted—Ed.].

When one takes into account the fact that this work is all figured on the basis of an eight-hour day, from similar work under California conditions, and that the city is in a position to "buy this experience" from men who have spent years on other similar work now drawing to a close, and that 15 per cent. is added over and above the Los Angeles costs in the form of "contractor's profit" and that other assumptions have been made with liberality, I believe it is feasible with good management and wise legislation to build the work within the estimated cost. Unwise legislation and poor management might easily add five million dollars or more.

Summary of Hearing Before Secretary Fisher on the Hetch Hetchy Water-Supply

By John R. Freeman

The five working days of Thanksgiving week were devoted by Secretary Fisher chiefly to hearing a strenuous presentation of diametrically opposite views regarding the revocation of the "Garfield Permit."

The secretary stated at the outset that the two main questions were:

(1) Whether there is or is not available in the Hetch Hetchy Valley a source of water-supply which is particularly available for San Francisco and if there is such a source, are its advantages over any other source available so great that the city ought not to be denied this, and asked to take the alternative source.

(2) If the showing made should indicate that there is water available, and that this site is cheaper and better for the city's use than the best of the possible alternatives, would granting the right to use this for domestic supply ultimately involve forbidding camping parties and tourists free access to the many square miles of the National Park area draining into it.

The writer and J. H. Dockweiler presented various figures and diagrams from the gagings of the U. S. Geological Survey, which they claimed demonstrated beyond all doubt that the run off of the watershed was ample to satisfy all irrigation priorities and that by storing flood waters now wasted it could supply from 400,000,000 to 500,000,000 gal. daily to the San Francisco Bay cities.

The writer claimed that to force San Francisco to go elsewhere for the water it would surely need, would involve an economic waste of from $20,000,000 to $30,000,000, and either be beyond the financial means of the city or lessen to

this extent the funds available for other municipal improvements.

Desmond FitzGerald, Prof. Geo. C. Whipple and Allen Hazen were all very positive in their statements that the sanitary safeguard of storage in a great reservoir is so efficient in destroying disease germs, and that this watershed is so remarkable in its character by producing a naturally pure and sterile water, that there is not even the most remote probability that it would ever become necessary to exclude campers from the vicinity or from the many interesting lakes, streams and mountain meadows lying further up the stream in the high Sierras.

At the request of Secretary Fisher the city's engineers presented a draft of sanitary rules which the city would agree to make part of its stipulation that nothing further of the kind would be called for, as follows:

(1) No human excrement, garbage or other refuse shall be placed in the waters of any reservoir or stream or within 50 ft. thereof.
(2) All sewage from permanent camps or hotels within the watershed shall be filtered by natural percolation through porous earth, or otherwise adequately purified.
(3) It is forbidden to bathe, wash clothes or cooking utensils, to water stock or to in any other way pollute the waters within the limits of the Hetch Hetchy Reservoir or any reservoir so constructed by the city or in the streams leading thereto within one mile of said reservoirs.

The testimony of Mr. Whipple and Mr. Hazen was to the effect that these sanitary rules were necessary for the protection of the campers themselves from other campers farther up the stream whenever their number should become large, regardless of whether the Hetch Hetchy was to be used for a reservoir or not.

Alternative sources, which the representatives of those who would like to sell them to the city claimed were cheaper or better, had their claims presented by various attorneys and experts, the strongest claims being set forth in behalf of the McCloud River, with an aqueduct having its intake about a hundred miles farther from the city than the Hetch Hetchy. The Sierra Blue Lakes Co. also had an attorney present, and the possibilities of the rights on Yuba River, owned by W. P. Bourn, president of the Spring Valley Water Co., were presented by the counsel of the Spring Valley Water Co.

The strongest opposition to the need of going to the Hetch Hetchy was presented by the Spring Valley Water Co., which now supplies San Francisco and which, through its counsel and its engineers, claimed to possess resources that could meet all of the real needs of San Francisco for nearly a hundred years to come. These resources consist of two or three coast streams, not yet tapped, wells in the bay shore gravels, riparian rights not yet drawn upon on the Coyote River and principally the additional water resources of Alameda Creek, obtainable by building great storage reservoirs on its Calaveras site and other sites, and by drawing on the water stored in the deep gravels of the Livermore Valley.

The writer and others strongly disputed these claims and said that the coast streams were impracticable because of cost and their torrential, flashy character; that recent court decisions made it unlawful to divert the water from the Bay Shore gravels and Coyote Creek to San Francisco, and that there were grave legal obstacles to diverting any such quantities as claimed from the Alameda Creek and Livermore Valley regions, because of conflict with rights of local use and that any such great conservation of flood waters on the deep gravels was a physical impossibility because of their irregularly impervious character. He also stated that the spring Valley Water Co.'s stream flow records are grossly inaccurate and crude.

Myron L. Fuller, consulting geologist and expert in ground waters, also disputed the possibility of large conservation of flood waters in the Livermore gravels.

The Modesto and Turlock irrigation districts also had lawyers and engineering experts present to oppose the use of the Hetch Hetchy by the city, on the ground that they would like this water themselves, but evidently were ready to make some trade with the city on the basis of having part of the water stored in Hetch Hetchy released to them in time of need.

The "Nature Lovers" were the most persistent opponents. They claimed that none of this land dedicated to the whole American people should be diverted so long as another source was available, regardless of cost. Robert Underwood Johnson, of New York City, went so far as to say that rather than give the city the rights asked for it should be compelled to distill water from the Pacific Ocean, and J. Horace McFarland, of Harrisburg, Penn., made a similar plea, but did not go so far.

Secretary Fisher impressed all by his evident intention to go to the bottom of all these questions and by the impartiality with which he took the witnesses of both sides into his own hands for incisive cross examination. In fact, the secretary led the questioning from the start and left little for the counsel on either side in the way of direct examination or cross examination. At the close the secretary stated that he had not reached a decision and gave the engineers for San Francisco until Dec. 23 to file specific answers to questions raised by himself and by members of the Advisory Board of Army Engineers during the hearing relating chiefly to costs of certain alternative sources.

The secretary's attitude on the water-power question was particularly interesting. He served notice on the city that it would be expected to develop this power promptly if the permit were granted and would be required to agree to furnish it substantially at cost for the development of the region and particularly for municipal purposes, thus releasing power now purchased from private corporations for general use outside.

German Circuit-breaker tests carried out with five oil switches of different makers at the power station in Rjukanfos, Norway, are briefly noted in London "Engineering," Oct. 25, 1912. It was found that all switches opened short-circuits of 40,000 to 50,000 k.v.a. at 12,000 to 13,000 volts, more easily than 10,000 to 20,000 k.v.a. at 3000 to 4000 volts. The reasons for this were not ascertained, but it has been attributed to peculiarities of the power station. The closing of a switch on short-circuit was nearly as injurious to the switch as the effects of opening one at such time. The volume of oil used varies among the switches in ratios of 1 to 10, and the switches with a larger amount did not appear to work better than those with a smaller.

The Effect of Screw Propeller Canal Boats on canal banks and bottoms has been investigated by the Prussian Hydraulic and Shipbuilding Laboratory at Charlottenburg. This laboratory has an experimental station, which can be fitted with any type of sections and material, and has also model motor boats which are driven through the channel. As a result of the experiments, the conclusion has been reached that the degradation of canal banks while being due to a helicoidal motion given to the water by the propeller depends chiefly upon the relative position of the rudder and the propeller, and also the destructive action may be mitigated by fitting the boat with two rudders, one on each side of the propeller. Experiments were made on a $\frac{1}{25}$ reduction of the Ems-Dortmund and Rhine-Weser Canals with model boats that made 2000 round trips, after which the effective erosion was noted. It was found that the tugs with one propeller were more destructive than those with two. It was also noted that for maintaining the normal speed with twin screws their number of revolutions must be 15% greater when turning toward than when turning away from one another.

It was also found that the rudder transformed the circular trajectory of a water molecule into an elliptic trajectory, the major axis being vertical, and that the water has an undulatory motion producing the well-known surface wave and also a wave in the canal bottom, which causes the erosion. On substituting two smaller rudders it was found, after 1000 voyages, that no erosion was made. It is stated that five years after the Ems-Dortmund Canal was opened, although the traffic was not considerable at first, the banks were brought so near together by the deposited material eroded by the wash of the propeller that two boats could not cross. In consequence of this difficulty recent German canals have had their bottoms sloping downward on each side to the center line. An account of these experiments appeared in "The Contract Journal," Nov. 13, 1912.

Letters to the Editor

Pitch vs. Grout for the Joints of Brick Pavement

Sir—I have read with considerable interest the article by J. E. Howard, on "The Thermal Effects on Brick Pavement," in your issue of Nov. 28, p. 1010. It has long been a recognized fact that a brick pavement is subject to a considerable expansion and this has usually been taken care of by tar- or asphalt-filled expansion joints. It is, however, the close and careful study of these changes in any class of construction work, which will enable engineers to exactly prophesy the resulting effects from temperature, traffic, etc.; and the more of this application of laboratory methods to the field there is, the better, I believe, our results will be.

Knowing that brick pavement is subject to considerable stress and change in volume due to temperature, it seems to me that Mr. Howard's conclusions are considerably at variance with the facts of the matter. I believe better results would be obtained by recognizing the expansion and providing means to take care of it. I also think that engineers will, in the near future, return to the pitch- or asphalt-filled joint and discard the cement-grout filler. The cement-grouted brick pavement is entirely too rigid to expect the grout to hold the brick throughout. Mr. Howard, himself, calls attention to the fact that the passage of the vehicles could be detected at a considerable distance on the pavement. The pitch- or asphalt-filled joint would give a resiliency which is much to be desired in any kind of pavement.

CLARK R. MANDIGO,
Assistant City Engineer.

Kansas City, Mo., Dec. 6, 1912.

[We are aware that many engineers agree with the writer of the above in preferring pitch for filling the joints of a brick pavement. On the other hand, the Association of Paving Brick Manufacturers, which has given most thorough study to this subject, is emphatic in its preference for a grout filler and requires the use of grout in its standard specifications. The Association has recognized that to secure the widest use of brick as a paving material, it must foster the laying of the brick in the manner which will produce the greatest satisfaction to the public.

It is undeniably a great advantage of the grouted joint that it makes so perfect a bond of each brick with the bricks adjacent that it is impossible by the heavy blows of traffic to push one brick or several bricks down below the others and thus start a depression in the pavement.

A further great advantage of the grouted joint is that the hard cement in the joint protects the corners of the bricks from being rounded off, so that the surface of the pavement is as smooth as a sheet pavement, while the surface of a pitch-filled brick pavement which has been in use for some time is covered with grooves of greater or less depth where the pitch in the joints has worn away.

Of course under the conditions of half a dozen years ago, it was a fair argument that such grooves were necessary to give a secure foothold to draft horses. Present-day pavements, however, must be laid with the wear of motor vehicles chiefly in mind, and here the absolutely smooth surface of the grouted pavement is a great advantage.—ED.]

Revenue from the Sault Ste. Marie Canal Traffic if Tolls Equal to Those at Panama Were to be Laid

Sir—In view of the recent proclamation of the President fixing the tolls to be charged vessels passing the Panama Canal, it is of some interest to consider what such tolls would yield if applied to that portion of the freight traffic of the Great Lakes passing the canals at Sault Ste. Marie.

The rates at Panama are based on the registered tonnage of the vessels, those carrying passengers and cargo being charged $1.20 per ton net register, and those in ballast, without passengers, paying 72 cents per ton net register. Each ton of net register is intended to represent 100 cu.ft. of cargo carrying capacity, and the relation of the net registered tonnage to the actual freight that may be carried by the vessel depends on the character of the cargo.

The arbitrary method of measuring the registered tonnage is not the same in different countries, and that to be adopted at Panama may not be the same as that now in use for vessels of the United States. In the traffic records kept at the St. Marys Falls Canal the registered tonnage of the vessels in ballast has not been separated from the registered tonnage of the loaded vessels. For these reasons the following computations, while close approximations, are not exact.

During the present season up to Dec. 1 the registered tonnage of all vessels passing the canals at Sault Ste. Marie was 55,889,368, of which 27,855,720 was eastbound and 28,033,648 westbound. The freight traffic amounted to 71,066,818 tons (of 2000 lb.), of which 54,515,338 tons was eastbound and 16,551,480 tons westbound. Nearly all eastbound boats are loaded. The freight tonnage eastbound is about 96% in excess of the registered tonnage; that is, for each net ton register the freight was 1.96 tons. Assuming that all eastbound boats were loaded and that the above ratio of freight tons to registered tonnage applies also to the westbound boats carrying loads, it is found that the registered tonnage of all loaded vessels amounted to 36,300,000, and that the registered tonnage of all light boats amounted to 19,200,000. On this basis, if the rates of toll fixed for the Panama Canal were applied to this traffic it would result in an income of about $57,500,000 for the present year to Dec. 1.

In two years this income would be more than sufficient to refund the total expenditures of the United States and Canadian governments on the River and Harbor improvements of all of the Great Lakes and their connecting channels.

If only one-half of the tolls for this year, alone, were paid to the United States, it would be more than sufficient to pay the entire original cost of all works of improvement on the St. Marys River between Lake Superior and Lake Huron, including the building, operation and maintenance of the locks and canal.

S. L. C.

Detroit, Mich., Dec. 6, 1912.

More Concerning the Economics of Road Improvement

Sir—I have read with interest and profit the extracts from the address of Nelson P. Lewis as published in ENGINEERING NEWS of Dec. 5, but I am unable to comprehend some of the financial statements.

In order to look at the subject from a different angle, let us assume that the abutting property to be assessed consists of 640 acres per mile of road, and that the first cost of construction of an improved road is $12,000 per mile, and further that 10% of this first cost, that is, $1200, is a sufficient annual charge to maintain the mile of road in first-class condition and to care for small repairs which are not included in maintenance;

in other words, the annual expenditure of this sum would obviate the necessity of rebuilding the road at a future date.

Then the financial statement is about as follows, the specific values being assumed in order to propose a numerical illustration and not because such figures are necessarily even approximately correct. One-third of the first cost and one-half of maintenance paid by the abutting property, either directly or indirectly. Using interest at 4%, this represents a capital of about $30 per acre. If this land is not worth that amount more to the owners, then the assessments are an unjust burden; and if the remaining capitalized cost of $23,000 per mile is in excess of the benefits derived by the state, then the reconstruction of that mile of road is an economic blunder.

Whether the state actually has the ready money on hand, or must borrow it for a few years does not alter the problem, so long as the maintenance charge is met from current funds, and is of sufficient amount to practically keep the road in its original condition. As to this latter consideration, there is a dearth of much needed information. I am unable to understand why this question of maintenance should not be more carefully considered.

CHAS. E. ROGERS.

Trinity College,
Hartford, Conn., Dec. 9, 1912.

[It is undoubtedly correct to compute that the entire cost of a road is equal to its first cost plus the sum which, placed at interest, will yield an annual revenue sufficient to maintain the road and make good any deterioration.

But we lack experience enough with the newer types of roads in which broken stone is bound with organic materials to say what annual charge will represent the road's deterioration. The probabilities are that besides the annual repairs, there will be required after some years entire renewal of the wearing surface. Indeed, this has already occurred in some cases after a comparatively short period of wear.

That the cost of maintenance of a road may be an even more important factor in the final cost of the road to the public than the first cost of construction is well brought out by our correspondent's letter.

As to the borrowing of money by the state, it is a well established principle of sound finance that the term of a loan should never be longer than the life of what the loan procures. A private individual who borrows money payable years hence to meet his current expenses is started on the high road to bankruptcy; but he may with comparative safety borrow money to invest in a permanent improvement to his property, or one which will at least long outlast the period for which the loan is made. The same rule applies to the finances of states.—ED.]

A Defense of the Electric Heater for Street Cars

Sir—In ENGINEERING NEWS of Oct. 31 we are very pleased to be able to read such a distorted statement as that entitled "The Passing of the Electric Heater on Street Cars." The correct interpretation to put on the title of this article is that the electric heater is so far superior to other means of heating that it is outdistancing or passing them all.

Taking up some of the mis-statements in this article, *ad seriatim:*

"Less than 10% of the fuel burned at the power house appears as heat in the cars." You, of course, realize that this also applies to the current used in the propulsion of the cars.

You say "the use of electric heaters makes a heavy draft on the power house in the winter months." If you will only look into the matter, you will find that the winter months' load on the power house is on the average approximately the same as in the summer months. There are a great many reasons for this, the main one being that the schedule is much less in the winter than in the summer. The severe traffic conditions also take a great deal of current in the winter which a great many engineers, like the one who evidently wrote this article, are pleased to blame on electric heaters, that being the only thing they can think of for an increased load in the winter.

The mis-statement that "it takes a greater amount of current to heat a car than to propel it" is so absolutely childlike that we will not waste time giving you data as to the amount of current necessary to propel a car and to heat it. We are inclosing, however, our bulletin No. 14, showing the average current taken per hour for the entire heating season of 1910 on one of the big New York City railways from which you will note that an average expenditure of 1 kw. per hour maintains the cars up to the required temperature of the Public Service Commission of this district.

If you happen to be acquainted with the fact that it requires about 120 watt-hours per ton-mile to operate a street car and that the average light car weighs about 20 tons or 40,000 lb., you can easily figure out that it takes 2.4 kw.-hr. per mile to operate a car under the most favorable conditions, as sometimes the watt-hours per ton-mile run as high as 180 for a 20- or 25-ton car. Figuring a schedule speed of 10 miles per hour, you have 24 kw. to operate the average street car. Our largest equipment of electric heaters in New York on the street cars demands only 12 amp. at 550 volts or 6.6 kw., even when turned on full, and this is in a car that weighs about 45,000 lb.

We are also glad to note that you are so misinformed as to think that the number of electric-heated cars will be materially reduced each year. We are sending you together with the bulletin a photograph we had made of an article appearing in the *Electric Railway Journal* of Nov. 2, from which it would appear that the large hot-air heater has one or two failings, and it is necessary to fall back on the reliable electric heater to keep the passengers warm.

You are evidently biased with the idea that the only cost of heating a car is either the coal burned or the current used. Please bear in mind that the comparative cost of initial installation, cleanliness, weight of the equipment, maintenance, sanitation and various other points are in favor of the electric heater.

CONSOLIDATED CAR-HEATING CO.,
BY THOMAS FARMER, JR.,
Vice-President.

Singer Tower, New York City,
Nov. 27, 1912.

[The article to which our correspondent takes exception was based on the statement of the engineers of the New York State Public Service Commission in their official report. It should be noted also that we disclaimed criticism of the use of electric heaters, "in climates where the winter temperature is such that the amount of heat necessary to keep cars comfortable is comparatively small."

We quote from the pamphlet sent by our correspondent as follows:

> During the year 1909 and for the first part of the year 1910 the ——— Ry. made exhaustive tests as to the various temperatures at which they would have to throw on the different points of heat in order to maintain the cars at the temperature specified by the Public Service Commission, which was that the cars should be maintained between 40° and 65° F. It will, therefore, be seen that no heat is required under this law until the outside temperature drops below 40° F., and, therefore, the heating season would only include days when the temperature was below 40° at any time if only for an hour. As a result of these tests they determined that the first point of heat should go on at 40°, the second point at 32° and the third point at 25° F. The majority of their cars are 30-ft. body and have a consumption of 4, 8 and 12 amperes at 550 volts on the respective points.

It appears from the above that no heat whatever is furnished to a car until the temperature goes below 40° F., and that with the electric-heater equipment referred to, the full amount of heat available is furnished when the temperature is at 25°; and no more heat is or can be given to the car, even if the temperature drops to zero or 20° below.

Ideas differ as to the amount of heat necessary to keep cars "comfortable," and the ideas of street-railway managers are often a good way off from those of their passengers.

Considering that a car speed of 5 or 6 miles per hour prevails, as in large cities, the electric power consumption for heat-

ing, even under our correspondent's very optimistic figures, amounts to some 50% of the propulsion power.

As for sanitation, we hope the electric heaters under the seats are always hot enough to kill the "bugs" in the dust and germ-laden air which circulates around and over them. Whether they are or are not, we hope to see the day when ventilation will be considered a necessary part of a satisfactory system of street-car heating.—ED.]

Reinforced-Concrete Ties for Street Railway Track

Sir—With reference to the writer's article under this caption, published in ENGINEERING NEWS of Oct. 3 (page 628), pertaining to the use of concrete ties on the Los Angeles Ry. system, several minor discrepancies appear (illustrated by editorial foot notes), which seemingly require some explanation of the basis for the original statements. As they exhibit a tendency of carelessness or deviation from facts on the part of the writer, he would be glad to correct such impression. In the main, these differences may be ascribed to slightly conflicting statements of Mr. McDonald (inventor of the tie and whom the writer interviewed for data embodied in the article) and the Los Angeles Ry. Co.

1. LIFE OF TIE—In a booklet issued by Mr. McDonald relative to this tie there appears the following: "The life of a wooden tie, inclosed in concrete and asphaltum, is about five years. The cost of relaying, including tie, material and labor, is about $5. The life of an exposed tie varies from 3 to 6 years, depending on the quality of timber and soil." Inquiry on such point to Mr. McDonald confirmed this statement. In a Los Angeles trade journal of Aug. 12, 1911, the accompanying is stated through interview with Mr. McDonald: "Estimating the average life of a tie at five years, the railways of the United States must use 45,748,000,000 ft. of lumber every five years" (speaking, of course, of steam and electric roads). The Los Angeles Ry. has given ENGINEERING NEWS the life of wooden ties in use on such system as 7 to 15 years, and such must evidently be assumed as correct under these exact conditions.

2. PRESSURE ON TIES—In an interview in July, 1911, Mr. Wendt, a representative of Mr. McDonald, made the following statement, published in a Los Angeles daily and confirmed by Mr. McDonald in the interview mentioned with the writer: "The concrete mixture, which consists of 4 parts of clean, sharp sand and gravel, 1 part crushed stone and 1 part portland cement, is poured in on the reinforcing rods, plates and sleeves. Then the whole is subject to heavy pressure." In a communication from the Los Angeles Ry. to the writer dated Sept. 14, 1912, C. A. Henderson, Assistant General Manager, informs him that "hand tamping" is employed. This, as printed in a foot note in ENGINEERING NEWS, must also be assumed as correct, but it is somewhat peculiar that Mr. McDonald, who has spent many years in perfecting this tie, would make this statement.

3. NUMBER OF TIES—In its final foot note to this article, ENGINEERING NEWS states that Mr. Henderson has advised that "The number of concrete ties already in use is a little over 8000." In the communication the writer received from Mr. Henderson, mentioned above, this is given as 7000.

The writer regrets that he was not in Los Angeles when these discrepancies first became apparent, so that they could have been personally and fully investigated, eliminating the differences evidenced in publication of the article.

LEROY W. ALLISON.
170 Roseville Ave., Newark, N. J.,
Oct. 14, 1912.

Sir—Referring to your inquiry of Oct. 18 in reference to concrete ties on the Los Angeles Ry., our chief engineer reports as follows:

1. The life of wood ties inclosed in concrete and asphalt should be from 7 to 15 years.

2. The concrete tie in manufacture is not subjected to heavy pressure, hand tamping being employed.

3. As to the weight of concrete ties, the figures given by Mr. Wolf are based on ties 7x8 in., 8 ft. long. The ties of the Los Angeles Ry. are 7x8 in., 6 ft. long, and weigh 395 lb. each, including rods, plates and sleeves.

4. Referring to the cost, this is given in the article as $1.15 to $1.25 per tie, but these figures are from 30 to 40% too low.

C. A. HENDERSON,
Asst. Gen. Manager,
Los Angeles Ry.
Los Angeles, Calif., Nov. 15, 1912.

Sir—Your issue of Oct. 3 has (on page 628) an article on the reinforced-concrete cross-tie being introduced in street-railway service in Los Angeles, Calif. The article is important in showing the wider use of the concrete tie in service, indicating that certain railway systems have passed the experimental stage of trying-out a few ties and are proceeding with construction on a larger scale. The making of 8000 ties by one system points to this unmistakably.

The article, however, contains an evident error in speaking of the weight of said tie. A cross-section of 7x8 in., 8 ft. long, and with concrete weighing 140 lb. per cu.ft., gives a weight (concrete alone) of 435 lb.; the six reinforcing rods 8 ft. long (if of ½-in. cross-section) weigh 43 lb., and if of ⅝-in. section, 65 lb. These weights added to the 435 lb. of concrete make a total weight of tie of 477 lb. and 500 lb., respectively. These figures do not include the weight of the top and bottom plates, nor the sleeves for holding the spikes. The total weight, therefore, of each tie must be in excess of 500 lb.

As to cost, it would seem that a tie containing 3 cu.ft. of concrete (or ⅑ cu.yd.), and having a minimum of 43 lb. steel reinforcement, could hardly be fabricated for from $1.15 to $1.25, and it would be interesting and valuable to have the extended figures.

As to serviceability: it would seem, from the experience of the several designs tried out in steam-railway service, that the life of the tie will be prolonged considerably by the use of a cushion of wood immediately under the rail. Some form of rail-insulation has to be considered in electric service, which contributes to the cushioning, but it is believed that the addition of a wood-block will be found desirable, if not necessary.

J. H. G. WOLF.
1023 Mills Building,
San Francisco, Calif.

[Publication of the above letters has been delayed in part by our efforts to obtain exact information to explain the discrepancies noted in the first two letters. We have not received from the inventor any reply to our inquiries, but the reply from the railway company supports the statements made originally. As to the life of wood ties embedded in concrete, the inventor's estimate of five years is manifestly too low, and no information was given as to the basis for such a statement. As to the manufacture of the ties, statements made to the daily press are no authority, and the fact is (as shown by Mr. Henderson's letter) that the concrete was tamped or rammed by hand and was not subjected to heavy pressure. It is possible that the inventor has proposed a pressure system, but that it was not considered advisable to go to the expense of building the necessary machinery for these first ties. The correct figures of weight and cost (which are far above the inventor's estimates) greatly reduce any showing of economy for this particular design of concrete tie.—EDITOR.]

Notes and Queries

D. A. W. writes:

In your issue of Nov. 28, 1912, p. 1016, is an inquiry about raft chutes in dams. There are several on the Moldau, in Bohemia. If your correspondent will refer to the Reports of the "Kommission für die Kanalisirung des Elbes-Moldau in Böhmen," and especially to their booklet, "La Canalisation de la Moldau et de l'Elbe en Bohème" (Prague, 1900), published for the Eighth International Congress at Paris, he will find plans and photos of raft chutes. These documents can be found in the American Society of Civil Engineers' Library, in New York City.

From another source we are informed that some of these chutes may be seen at Ottawa, Can., and that there are others along the Ottawa River.

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*Illustrated.

Engineering News

Assessments for benefits as a means of raising funds to meet the cost of municipal improvements seem to be on the increase. Until recently such assessments were rarely made except for opening, grading and improving streets, laying sidewalks, and building sewers. During the past few years New York City has adopted the principle of assessing benefits for all public improvements which increase the value of real estate in such a way that the increase can be determined for purposes of assessment. This, we understand, has been applied in the case of parks. In the District of Columbia at least one-half the cost of land for parkways of some length and at least one-third the cost of land for public parks is hereafter to be assessed as benefits. There is much to be said for the wider adoption of this principle and practice as a matter of justice, and still more as a matter of expediency for the purpose of finding money to meet the cost for the almost unlimited current demand for municipal improvements.

Good Maintenance?

To keep structures in good and safe condition by painting and repairing may be regarded as the sum and substance of maintenance. But this is a narrow view, and (as recently illustrated) a dangerous view. Unless the authorities in charge of maintenance make it their business to revise and reëxamine their structures from time to time in order to see that they are adequate for their work, occurrences like the Glen Loch bridge failure are bound to happen.

In writing of that bridge in our last issue, we remarked that a full account of the damage which the structure suffered in the train wreck of Nov. 27 had not been given, and that such an account would be essential to a full understanding of the accident. It is fortunate that such an account is now available to bridge engineers in the article of C. A. Wentworth on another page of this issue. The account brings out the fact that the design of the bridge was not suited to the service. Certain details were defective, the bridge was not stiffened, and there was neither bracing nor anchorage to resist the centrifugal stress of heavy trains rounding the curve.

In railway service increase of weights and speeds of trains is constantly making old bridges obsolete and inadequate, though they were perfectly adapted to their service at the start. The last few years have shown that not many bridges more than twenty years old are still capable of carrying maximum present-day traffic. The Glen Loch bridge, built in 1891, is about at this limit of life. Yet its failure appears to be not so much a case of being outgrown by the service as a case of unsatisfactory design even for the traffic of the time when it was built.

The responsibility of bridge inspection and maintenance extends to conditions of this kind. Discovery or prevention of deterioration is not enough, but the structure must be reviewed from the ground up, or rather from the first element of design on. The engineer charged with maintenance must be prepared to say, at all times, that all details and also the structure as a whole are adequate for every contingency of service, and are in condition to do their work effectively. Inspection means not merely to see that things are as they were a year ago, but to see that they are right.

All this may be self-evident statement, mere repetition of known matters. But if it be repetition, it is justified by the accident which revealed the neglect of these self-evident matters. Failures of structures are not altogether rare, and every failure implies not only a defect in the structure, but also a defect in the system of maintenance which was responsible for that structure.

Is It Safe to Further Increase the Wheel Load of Locomotives?

In one of the discussions at the recent annual meeting of the American Society of Mechanical Engineers, it was stated that the mechanical department of one of the largest railway companies is seriously considering the design of a passenger locomotive having a maximum axle loading of 70,000 lb. The proposition was put forward that such loadings might be safely undertaken if the weights of reciprocating parts were reduced so as to bring down the amount of the so called hammer blow.

It seems to us worth while at this time to enter strong protest against any further increase in the loads which are imposed on the steel rails, track and bridges of American railways. The claim that by bringing down the weights of the reciprocating parts and the resultant hammer blow, the maximum pressure on the rail will not be increased, notwithstanding the increased axle loading, is, we believe, fallacious. It is, of course, true that the combined effect of the reciprocating and rotating parts of the locomotive machinery does produce an excess pressure upon the rail at high

speeds; but it is a fallacy to think that this is the only dynamic force to be considered in studying maximum stresses on steel rails.

It should never be forgotten, for one thing, that a load of 70,000 lb. per axle is not the same thing as a maximum wheel load of 35,000 lb. In the movement of a car or locomotive over a track at high speed, or even at low speed, the load may not be equally distributed upon the two wheels of an axle. In rounding a curve, for example, if the train is run at a higher speed than that for which the outer rail is elevated, an excess of weight will be transmitted to the outer rail; or if the train is running at a lower speed than that for which the curve is set up, the inner rail will get more than its half of the weight.

Again, the distribution of weight to the several wheels of a locomotive is dependent on the action of the equalizing levers; and their movement is by no means highly accurate and is subject to considerable variations when running over rough track at high speed. Even when track is in good line and surface, the locomotive is not running upon an unyielding perfect plane, but upon a yielding elastic surface which acts and reacts upon the locomotive structure very much like a compressed spring. A ride upon the footplate of a locomotive reveals to the senses how much motion and play there is to the great machine; and one has but to watch a construction locomotive traveling slowly over rough track to see how much motion there is in the various parts of the running gear.

Careful consideration of all these factors must lead to the conclusion that with a maximum static axle load of 70,000 lb. the actual pressure of a single wheel of the axle upon the rail under the various dynamic forces may exceed the half of this static load by probably 25 to 50% or even more.

Surely, the stress which all parts of the railway track and its supporting structures are now sustaining, with the present wheel loads and speeds, is quite sufficient without asking these parts of the railway's equipment to perform further miracles.

If, indeed, there were some great advantage to be gained by further increasing locomotive wheel loads, there might be reason for further inquiry and study as to the possibilities of safely stressing further the steel rail and its supports. The indications are, however, that in American railway practice we have, if anything, allowed the pendulum to swing too far in the direction of increasing the power of locomotives. What has been saved in certain directions by this increase has been more than made up by losses in higher maintenance costs of rolling stock and track, with a regrettable paring down of the factor of safety. There are surely other directions in which the locomotive can be improved to much better advantage than by further increasing the maximum static and dynamic loads which it imposes upon the rails.

The Better Utilization of Bituminous Coals

The present difficulty in securing ample supplies of anthracite for domestic heating, still felt as a result of the three months' cessation of mining last spring, draws closer attention to the problem of rendering other coals from wider-spread deposits suitable for household use. There are many localities where prices of $8 per ton for anthracite, due to the distance from the mines, and $2 or $3 for local bituminous coal dictate the use of the latter fuel, in spite of its wastefulness and attendant discomfort. If an "artificial anthracite" were widely available in these regions, it would be a great boon to the people therein, and a true measure of conservation of local resources.

The modification of bituminous coals has been one of the more important studies carried on in the past three years by the University of Illinois' Engineering Experiment Station. That state is rich in deposits of this soft fuel, but anthracite is comparatively expensive. The engineers of the University must have had a constant daily reminder of the economic waste in their own university communities of Urbana and Champaign, where each winter morning as the householders fed their furnaces the air was polluted with a murky odoriferous fog, which hardly settled or was blown away before the next firing period came.

The results of the latest study at the University of Illinois are presented elsewhere in this issue. The investigators, Prof. Parr and Mr. Olin, have shown that it is feasible to make a dense coke or an "artificial anthracite" which will give a better winter atmosphere and contribute materially to the domestic-economies comforts of that state. But still more important from an engineering point of view is the fact that the process thus indicated gives great economies in the utilization of the fuel resources of the state.

In the modification or distillation process, only low temperatures are to be employed; these result in increased percentages of fixed carbon in the solid fuel, increased percentages of tarry by-products and decreased percentages of gas. It is this increased and improved tar to which we desire to draw attention at this time, for with the rise of the Diesel type of engine and the demand of the millions of small internal-combustion motors we shall have to look carefully to our sources of liquid fuel.

The yield of tarry products is reported to be some 8% of the weight of coal used—equivalent to about 20 gal. per long ton, which is twice the average yield for the coal-tar producers of the country and five times the minimum.

The notable quality of the tar secured is apparent in comparing its analysis with those of typical gas tars. It is seen that the tar in question contains about 75% of oil which can probably be directly used in the Diesel type of engine (unless too valuable in the arts as hinted at by the investigators). In the other tars some of the lighter fractions are largely the solid "tar-camphor" (naphthalene) and the remainder only heavier products which cannot be any too easily used even in the Diesel engine.

By burning a ton of these coals under a boiler and using the steam in the best of engines, we might develop 1,500 hp.-hr. (assuming the extremely good performance of 1.5 lb. per hp.-hr.). By using the products of a low-temperature distillation process we could develop somewhere between 2000 and 2500 hp.-hr., depending on the heat required at the retort. We could get 2100 hp.-hr. from the coke residue (using 0.8 lb. per hp.-hr.), 350 hp.-hr. from the oil (using the Diesel-engine figures of 0.5 lb. per hp.-hr.) and 80 hp.-hr. from the gas (13,000 B.t.u. per hp.-hr.).

Here is pointed out the chance for and the utility of a great industry at the mines. Gas enough can be generated from the low-temperature distillation process to run the plant and light the premises. Coke and culm briquettes can be shipped for domestic consumption, together with oil for use in the Diesel and similar engines.

Further Light on the Effects of Electric Current in Concrete.

In our issue of last week we gave liberal space to a review of the general results so far secured in a partially com-

COMPARISON OF COAL-GAS TARS

Percentages	Univ. Ill. Expenses		Low-Temp. Gas-House[1]		High-Temp. Gas-House[2]	1000° Coke-Oven[3]
Water and ammonia	0		0.3		4.0	2.0– 1.0
Fraction A	(–100°)	10.5	(–100°)	4.4	2.5	2.8– 1.0
Fraction B	(100°–200°)	29.1	(110°–170°)	16.5	17.5	15.9– 6.0
Fraction C	(200 –240)	29.8	(170°–270°)	33.5	17.0	31.5–32.8
Fraction D	(240 –275)	5.5	.....			
Pitch Residue	.....		45.3		59.0	47.8–59.2
Free carbon (Per cent of pitch)	.....		20.9		30.9	6.7– 8.6
Coke residue	21.3		.....		....	.....

From Prevost-Hubbard "Dust Preventives and Road Binders."
[1]Trace of napthalene in Fraction B; 50% in Fraction C.
[2]Fraction B carries 66% napthalene; Fraction C carries 40%.
[3]Fractions B and C nearly all napthalene.

pleted investigation by the U. S. Bureau of Standards of the effects of electric currents on concrete. The findings, though abbreviated in every possible way, were so numerous and varied that their presentation ran to great length. The most important investigations, of those which have been made in this country at least, have been presented in our columns at various times during the past six years,* but, in comparison with all of these earlier efforts, those completed and still under way at the Bureau of Standards form the most complete and comprehensive series of studies which have been attempted. The benefit is apparent of having an institution like this equipped to push such long and complicated researches to completion without serious interruption. The previous researches in this particular line have been the work either of individuals hankering for knowledge or schools anxious for practical thesis investigations with teaching value. In the first case the available funds and equipment are limited; in the second case, the scope of each study and the time available are restricted.

These latest tests are surprising, both in what has been found and in the failure to find some expected results. In the main, they corroborate the findings of earlier investigators, but they add complexity to the trouble rather than simplicity.

Perhaps the most surprising information secured is that softening of concrete and loss of bond to imbedded iron have been found *with currents flowing from concrete to iron.* These results are positive where the earlier findings have been merely negative. The failure of others to note this action may be attributed to the slowness of the secondary reactions which result in this disintegration and to the much greater length of time in which the Bureau of Standards' investigators were able patiently to pursue their work. It is evident that if the bond of the reinforcement to the concrete mass is lost, in a reinforced-concrete structure, then disaster impends. This danger is even more insidious than those other electrolytic effects with which we have become acquainted, for there are no expanding products to crack the structural members and give warning of the impaired condition which exists in the interior.

A second important piece of information secured from this investigation relates to the "efficiency of corrosion." We have long been familiar with the fact that the total amount of corrosion of iron imbedded in concrete *with current flowing from iron to concrete* is less than what would be expected from the laws of electrolysis. In these investigations, with very low current densities (amperes per square inch of imbedded iron) the efficiency dropped nearly or quite to zero; but with increasing electrode current density this efficiency of corrosion gradually increased up to some 40%. That is to say, there seem to exist certain inherent protective tendencies which are destroyed by currents of sufficient magnitude to produce perceptible heating. With very low current densities, the corrosion was slight and the laboratory specimens did not crack. With higher current densities, the temperature rose, the amounts of iron dissolved from electrodes greatly increased and the specimens were ruptured.

In some of the earlier experiments, a similar differentiation has been shown between the effects of small and large currents, though it has not been understood before this that the action of the larger current was anything more than a purely thermal expansive effect. It now appears that it may be either mechanical or as an accelerator of electrolysis, or both.

It is well to warn our readers, however, that, in spite of the fact that a year and a half of trial with very low current densities has resulted in failure to find disintegration with current flowing from iron to imbedding concrete, we must not immediately assume that the action cannot be found under the same conditions after several more years have elapsed. It may be so slight, in one or two years, as to seem not to develop, becoming only barely appreciable in five years and producing dangerous stresses only in the course of a quarter or half century.

A third important point disclosed by these studies is seen in the widely differing conditions imposed by permitting chlorides to come in contact with the concrete and in taking pains to exclude them completely. This in itself may explain some of the differences which are found between the results of this investigation and of earlier ones, for the majority of investigators immersed their test specimens in brine so as to reduce the electrical resistance of their circuits in order to accelerate the effects under study.

It appears now that salt plays a doubly troublesome part; first, it prevents the concrete from naturally increasing its resistance in the vicinity of electrodes as current flows through it and, secondly, it remarkably increases the "efficiency of corrosion," one-third of 1% addition to the material of a specimen, causing corrosion to rise to 80% of the theoretical value. The warning of the Bureau of Standards against the use of salt to prevent freezing may well be repeated here.

There are a large number of other points about the investigation which are deserving of study and which can receive only the briefest comment here. For instance, the ingenious ways in which the tests have been planned to secure light on the causes of the various phenomena noted—such matters as the rise of resistance due to the formation of calcium carbonate in the outer pores of the concrete, and the cathodic disintegration due to the electro-endosmotic concentration of soluble alkali in the vicinity of the iron cathode. The Bureau of Standards' studies confirm the tentative conclusions of earlier investigators that conduction in concrete is electrolytic and that any disturbing effects must be electrode effects, effective only in the vicinity of the imbeded metal and not affecting the more distant concrete in any manner otherwise.

It is noteworthy that the present reports from the Bureau of Standards say nothing whatever about the effects of alternating current. At first thought, knowledge that trouble may arise with current flowing either from iron to concrete or in reverse direction would seem to lend color to the supposition that an alternating-current trouble may be found if the tests are prolonged sufficiently. A more careful study of all of the results of this latest investigation and a comparison with the various earlier studies shows that there is still sufficient ground for believing that alternating current will not produce either of the effects found with direct current. We have already noted that specimens could be cracked by thermal effects whether the current was direct or alternating, a fact that was only to be expected. Alternating-current tests covering several months, however, have not shown evil effects under low-current densities. We have previously pointed out that if the secondary reactions which set in with direct current do not have a sufficient velocity, then the reversal of current will in itself practically prevent corrosion of iron and concentration of alkali. This is all the more to be expected since it has been found that with low-current densities of direct current the efficiency of corrosion is very low. It is well to note, however, that the presence of chloride on or in the concrete may so hasten the secondary reactions that the already-known or some yet unsuspected troubles may set in.

*Tests of A. A. Knudson, Mar. 21, 1907, p. 328; Tests at the Massachusetts Institute of Technology, by U. J. Nicholas, Dec. 24, 1908, pp. 710-718; Tests at Washington Univ. (St. Louis, by Langsdorf and Glauber, Apr. 29, 1909, p. 458; Tests at Rensselaer Polytechnic Institute by Eltinge and Beers, Mar. 31, 1910, pp. 372, 376; Tests at the University of Melbourne, by U. J. Nicholas, Dec. 1, 1910, p. 590; Tests at Washington State Univ., by Magnusson and Smith, June 8, 1911, p. 637; Tests at the University of Vermont, by Upson and Barker, July 6, 1911, pp. 10, 19; Injury to a Packing House, H. P. Brown, June 8, 1911, pp. 684, 699; A British Example of Electrolysis, Aug. 17, 1911, p. 207.

A Work-Quantity and Unit-Cost Municipal Budget System

Engineers are continually running amuck of legal red tape which hampers them in the efficient and economical execution of their work. There is now being added to this, particularly in municipal work, many new restrictions which originate with the accountants.

Far be it from us to urge that either legal forms or accounting methods should be treated with disdain by the engineer. There is great need, however, for co-operation between the engineer, the lawyer and the accountant, to the end that each may understand enough of the fundamental principles underlying the work of the other to insure harmony instead of conflict.

In the past, most engineers have been too modest or too engrossed in what they have conceived to be the strictly professional side of their work to take their proper place and part in the formulation of policies and methods which vitally affect the efficiency of municipal engineering and public works. Engineers have let the lawyers frame state and municipal legislation and the accountants set up systems of accounting just as though the great bulk of city expenditures, outside of those for education, did not go for engineering works and just as though the success or failure of city government did not depend largely upon the way such works are designed, built and operated.

This should be changed. The engineer should take the place which he alone can fill and do his part, which is large, in formulating ways and means to insure economy and efficiency in municipal government.

We devote considerable space elsewhere in this issue to an illustration of how two engineers in the Borough of Richmond, New York City, ably backed by their borough president, have succeeded in having a trial made of what, so far as we know, is an innovation in budget making or the way of appropriating money for conducting municipal work in a year to come. We may add that the article should not be passed over as one dealing with budget matters only, for the greater part of the article consists of valuable engineering data on street-cleaning methods and costs; data compiled with unusual care and which can be matched by few if any American cities.

Although recent reforms place the New York budget ahead of the budgets of most American cities, it is still far short of what the budget reformers have given us to understand a budget should be. It fixes rigidly the purposes for which money may be spent and affords a check against expenditures for any other purposes (as well as a check against stealing) but the designated purposes or segregated "funds" are to a large extent arbitrary accountant's titles, instead of following functional lines, and there is nothing to insure that the money within each "fund" will be so used as to give the volume and the quality of work on which the estimates for any well conceived budget are supposed to be based. Moreover, once a department head has forecasted 15 to 18 months in advance how his total appropriation for the ensuing year shall be divided, and the forecast has been adopted by the budget board (or another estimate substituted by that board) that official is given no further discretion in the distribution of his appropriation between the several and largely meaningless "funds" which make up his budget.

As we have already said, the segregated items or "funds" into which the department or bureau appropriations are cast are based too largely on arbitrary or chance classifications. Where a reason for a "fund" can be found it is likely to be the prevention of some abuse which ought to be controlled by holding official heads strictly accountable for results obtained and for the discipline of their staff and employees.

One of the chief of these abuses in the past was padded payrolls and unwarranted rates of pay. Accordingly, heads of bureaus and departments are robbed of all discretion as to numbers and pay of subordinates, from deputy chief to the lowest paid laborer. The number of men in each class is rigidly fixed, and all in a given class are put on a dead level of salaries or wages, regardless of efficiency. This is not all. Equally hard and fast lines are drawn as to expenditures for materials and supplies. If seasonal or market conditions change so that either cost or quality of work to be done demands less of labor and more of supplies, or more of supplies and less of labor, the present budget system is inflexible against any transfer from one fund to the other.

Those who wish to pursue further the inadequate "fund" classification system of the New York budget may find food for reflection in Table VI and in Fig. 1 of the article to which we have already referred as appearing elsewhere in this issue. As will be seen from the first part of the table, a total appropriation of about $225,000 is divided between a dozen "funds" which have no relation to the quantity and efficiency of the work of the bureau, but with which the expenditures to the close of each month must be laboriously compared lest some of the "funds" be overdrawn while others, perchance, contain large balances which will be lost to the department at the end of the year unless the borough officials can induce the city budget board to transfer these surpluses to some other fund. It will be noticed that only 4 of the 13 "funds" exceeded $10,000, while 5 of them were not over $3000—yet not a dollar can be lawfully transferred from one to another of these small funds without going to the Board of Estimate and Apportionment and taking the time of nine or ten men (mayor, borough presidents, etc.), who are responsible for the financial and general administration of a city of five million people.

It is only fair to the budget reformers to say that at the outset they recognized the importance of having budget estimates correlated with the amount and quality of the work to be done. But so far as we know they have devised no adequate means to that desirable end. True, the New York Bureau of Municipal Research (the voluntary private organization back of much of the budget and accounting reform thus far accomplished in New York City), in coöperation with the Health Department, worked up a Health Budget some years ago which abounded with tabular forms for supporting the estimates submitted by that department. But the tables failed to correlate work done with money expended in accordance with any plan which showed the efficiency of the work.

Even the "fund" classification was largely meaningless, apparently having been based on extensions of the work of the health department or additions to its appropriations which for one reason or another seemed to make it desirable to open a new bookkeeping account. However this may have been, why should there be one "fund" for "Contagious Diseases" and another for "Communicable Diseases" and why should Health Commissioner Lederle be subject to dire punishment if he overdraws one of these funds when he has a surplus in the other?

We do not go so far as one of the Richmond Borough officials seems to have done in wishing for a return to the old time lump-sum appropriations to each department or bureau. Nor are we sure that many of the absurdities of the "segregated item" or "fund" system of the present budget are not the fault of the administrative officers of the several departments and bureaus—inheritances from that plan of controlling the operations of city officials which had no well defined object except to prevent either the stealing of funds or the use of money according to the fancy of the individual official or of a party boss. That plan, in so far as it involved a system of control, was based on cash accounting, with "funds" which might almost as well be designated by numbers as by names, so far as they related to the functional object of expenditures.

In contrast with this old system, plus whatever budget improvements have been introduced in New York City, and those are meager at best from the efficiency viewpoint, the Richmond Borough officials, after two years of hard pleading, are to be permitted to try a new plan, in three bureaus having to do with public works. This plan, as stated in detail elsewhere in this issue, lays out for each quarter of the year the amount of work to be done in that quarter and bases the appropriation for that three months upon those quantities, multiplied by estimated unit prices. The work laid out for these quarter-year periods is correlated in character and amount with seasonal requirements, and presumably the unit costs are varied in the same way. At the end of each quarter appeal may be made

to the Board of Estimate for transfers to meet the conditions already encountered and those which can be anticipated.

However this plan may look to accountants who, like lawyers, are strongly averse to changes in established practice, we think it will make a strong appeal to engineers. We are not concerned just now with the applicability of the plan to municipal departments which, for one reason or another, cannot estimate and finally measure expenditures in unit costs and thus judge efficiency of administration by that means. The Richmond Borough officials, however, did not ask that the plan be applied except where unit costs are or can be made available.

It will be seen, as one of the Richmond engineers has pointed out, that the Richmond budget plan is in its fundamental idea like the contract plan in so far as it involves estimates of quantities and unit prices for work and a total appropriation for each class of work based on those estimates.

Municipal engineers elsewhere might find it profitable to consider how the Richmond Borough work-quantity and unit-cost budget system would work in their cities. Even if they are not quite ready to advocate the plan for their own cities, they may do some good by placing and keeping before their city authorities the principle that the only rational system of budget making is one which is based on the functional operations to be conducted rather than on a chance series of unrelated "funds," each of which may have little significance, and the facts deducible from which may be readily deduced from any adequate system of municipal accounting.

Meeting of Irrigation Engineers at Fort Collins

BY SAMUEL H. LEA*

A conference of irrigation experts, comprising engineers of the Reclamation Service, other engineers interested in irrigation, and practical irrigators, was held at the Agricultural College, Fort Collins, Colo., Dec. 5-6. The attendance was good, there being 70 delegates registered. The program comprised 26 papers besides an illustrated lecture on the work of the U. S. Reclamation Service.

The first paper was one on "Measuring Devices," by Prof. E. B. House, of the Agricultural College. Several models were shown including the Venturi meter and various kinds of measuring weirs. The paper was of interest in view of present sentiment in favor of water conservation.

Dr. Chas. A. Lory, president of the Agricultural College, spoke on "Plan of Water Delivery," citing a case where a local reservoir system was able to increase the duty of its water from 25 to 50%. A natural basin was used and the water turned into this at such times as it was not needed for direct irrigation; it was possible to take about 4 ft. of water in depth, off the top, back to the land over which it had flowed. He explained a statement system, which was much like a bank statement, showing the quantity of water on hand and the condition of the account of each water user. These statements were made to the water users each week.

John L. Armstrong, water commissioner of Colorado, in a paper on "Exchange System," explained how in a certain district in Colorado a given amount of water is exchanged so that a ditch higher up uses it, paying back later out of a reservoir lower down. This system makes possible the economical irrigation of large areas, preventing losses through seepage and evaporation in long transmission.

A paper by Paul Rothi, of the U. S. Reclamation Service, on "Return Flow from Irrigation," was read by Andrew Weis in the absence of Mr. Rothi. The statement was made that a much larger quantity of water than is generally supposed returns to the stream after having been used in irrigation. It was also stated that there is often a heavy loss of water from excessive irrigation. He cited the interstate project on the North Platte River between Whalen, Wyo., and Bridgeport, Neb. Measurements made in 1910, 1911 and 1912, showed that of the water applied, 13, 14 and 15% in these years, respectively, found its way back into the stream.

A. R. Honnold, legal examiner for the U. S. Reclamation Service, read a paper on the legal status of return waters. Referring to the right to appropriate seepage water, the Colorado statute holds that such water can be appropriated the same as water from a running stream except that the owner of the land on which it first appears shall have a prior right.

Prof. V. M. Cone, irrigation expert of the Colorado Experiment Station, read a paper entitled "Duty of Water; Economy in Water Use and Damage from Excess Use." He said that the duty of water in Colorado is 18 in. a year and that 9 in. could be made to produce as good or better results if properly used.

James T. Whitehead, president of the Water Users Association under the North Platte Project, spoke on "What Constitutes Good Service from the Water Users' Standpoint." The association named is considering a proposition to make three classifications of the soil, giving sandy soils 36 in. of water and others in proportion and making the charge for maintenance $1 per acre-ft. of water per year. On this point there was considerable discussion, a majority appearing to favor a system of soil classification as a basis for the proper distribution of water.

In a paper by Dr. W. P. Headden, on "Alkali Action on Concrete," a number of instances were cited where total failure of concrete structures had resulted from the action of alkaline soil water. He took the ground that it is unwise to build structures of concrete if they are to be exposed to strongly alkaline waters.

C. T. Pease, project engineer of the Uncompahgre Project, spoke on the "Size of Farms." According to his observation the best returns per acre have been obtained on 40-acre tracts.

Samuel H. Lea, state engineer of South Dakota, spoke on the "Importance of Water Measurements." He cited how the meter system in cities prevents waste of water and declared that the same principle would apply in irrigation and that nearly one-half the present water-supply would be saved if irrigation water were measured and irrigators caused to realize the importance of conserving their water.

An illustrated lecture by Supervising Engineer R. F. Walter, of the U. S. Reclamation Service, was descriptive of the work of the Service. The cost of water storage on the various projects was stated to range from $5 to $25 per acre-ft.

*State Engineer of South Dakota, Pierre, S. D.

Provisions for Burning Oil Fuel under the boilers of the White Star Line "Olympic," is now being made, according to a recent press dispatch from London. The boat is at a Belfast shipyard undergoing extensive alterations, which consist of the construction of a complete inner steel hull, separated from the outer shell by a 3-ft. space. Part of this space it is proposed to use for the storage of oil fuel which will be used to supplement coal fuel for the boilers.

The Expenses of the Public Service Commission for the First District of the State of New York are estimated at $1,763,000, for the year 1913, according to the recent request of the Commission to the Board of Estimates and Apportionment of New York City. The Commission's budget for the year 1912, was $1,554,500. It will be recalled that this commission is a state body, but the state pays only the salaries of the commissioners, its counsel and secretary. The bulk of the expense is incurred for rapid-transit work in New York City, and this will take more than $1,300,000 of the total budget for 1913. The increase over the year 1912 is reported due to the work on the new subway lines. It should be noted that part of this expense money will be returned to the city in future years, since the operating contracts for the new subway, as prepared by the Commission, will include the engineering expenses of the Commission as part of the cost of construction, and a sinking fund will be provided to amortize this cost out of earnings during the life of the operating lease.

The Glen Loch Wreck—More Facts

By Charles A. Wentworth *

The Glen Loch bridge-and-train wreck was not studied fully enough by the Pennsylvania R. R.'s investigating committee. The committee did not describe the injuries to the bridge or refer to its design. The missing facts are brought out in this article. The design of the bridge was defective. The effect of centrifugal force from the 2° curve was not provided for. The post cap detail was also faulty.

*Consulting Engineer, Empire Bldg., Philadelphia, Penn.

The report* of the committee of Pennsylvania R.R. officials which investigated the wreck of Nov. 27, 1912, on Bridge 43½, near Glen Loch, Penn., leaves much to be desired from an engineering point of view. There are several features in the design of the wrecked bridge that are not in accordance with good practice in bridge design. Apparently certain forces which the bridge was obliged to resist were not considered at all or were left to be taken care of by the factor of safety, as the design provided no adequate means of resisting them.

The general poor design of the bridge, the breaking of the cap-plate of Post 7, the lateral deflection and wrecking of the box-girder (forming the top of the trestle bent) from Post 8 to Post 6 and especially between Posts 6 and 7 directly under the track used by the wrecked train, the bends in the westerly north girder, and several cracks in the iron of the bridge (some of which are old cracks), are not mentioned. The testpieces cut from the broken cap-plate of Post 8, while they may meet the P. R.R. requirements for merchant bar iron, would never be accepted as satisfactory for bridge material by a competent engineer, on account of the high phosphorus content (0.25%) and the brittleness shown by the bending tests. The centrifugal force of a train on the curve is also not mentioned. The slight scratch in the northerly rail is given a good deal of prominence, more than its extent would seem to justify when compared with other facts and with the failure to find anything that could cause a derailment. The testimony of both engineers and firemen in the partially derailed locomotives that their first sensation was a sudden dropping and then rearing up of the engines would not correspond with a derailment by hitting an obstruction.

*Engineering News, Dec. 19, 1912, p. 1172.

The writer personally examined the wrecked bridge on the morning of Nov. 29, and holds a different view than the committee as to the cause of the accident, although the failure of the defective cap-plate on the most northerly column of the trestle bent, to which they attribute the failure of the new bridge, undoubtedly contributed to and greatly increased the extent of the wreck.

FIG. 1. BRIDGE 43½ AT GLEN LOCH; LOOKING WEST ALONG WESTBOUND PASSENGER TRACK

FIG. 2. SOUTHWESTERLY PART OF SUPPORTING BENT OF BRIDGE 43½, AS SHORED UP AFTER WRECK OF NOV. 27; SHOWING TYPE OF CONSTRUCTION

DESCRIPTION OF THE BRIDGE

To obtain a good idea of the cause of the wreck a description of the bridge over the Trenton Cutoff tracks is essential. This bridge is of the through plate-girder type and was built in 1891; the material is all wrought iron, of apparently a good quality as shown by several fractures, but showing a decided grain or fibrous appearance where breaks occur along the grain. The main-line tracks and the tracks of the Trenton Cutoff are very nearly parallel at this point, the angle between them being about 15°, so that the bridge has a very sharp skew and is about four times as long as would be required for a square crossing. Between the lower tracks is a masonry pier about 6 ft. high, and to the top of this pier are fastened columns composed of two 12-in. channels latticed. The channels of the columns were turned facing each other, and were latticed on both sides, the outside dimensions of the column being 12 in. square. At top and bottom, gusset plates ½ in. thick served for connecting 6x4x½-in. angles 24 in. long, which in turn supported 1⅛-in. thick sole and cap plates 24 in. square.

The columns support a box-girder composed of two web-plates 23½x⅜ in., four angles 3½x3½x⅜ in., 24 in. back to back, and a cover-plate 24x½ in. The bottom is double latticed with 2¼x$\frac{7}{16}$ in. bars. The clear distance inside between the webs is 16¼ in. This girder had stiffener angles over the columns, but had transverse diaphragms at each end only, secured to the end stiffeners; no diaphragms were provided at the interior columns. The box-girder was secured to the column caps by four ¾-in. bolts. The columns of the trestle bent were diagonally braced in pairs. Each column was secured to the masonry of the pier by means of four ⅞-in. foundation bolts, upset to 1$\frac{1}{16}$ in.

The main plate-girders of the bridge were 7 ft. deep and had flanges composed of two 6x6x$\frac{7}{16}$-in. angles and a cover-plate 14x⅜ in., except for the top plate on the westerly girder on the south side, which is 14x$\frac{7}{16}$ in. The web-plates are 83½x⅜ in. There are two girders on either side of the bridge, the adjoining ends resting on the end of the box girder of the trestle bent directly over the end column, the other ends being secured to the abutments. The skew of the bridge is so great that only about one-half of two of the girders comes opposite one another, about three-fourths of the total length of the girders on either side coming in the skew portion of the bridge. (See framing plan of bridge, Fig. 5.) The girders are connected to the box girder by two ¾-in. bolts in the bottom flange of each main girder near the end.

The floor joists are 15-in. heavy I-beams spaced 2 ft. 8 in. on centers, and carry 7x10-in. and 10x10-in. yellow-pine stringers, one under each rail. One end of the joists rests on the lower flange of the main girders, secured to them by angle-iron riveted connections; the other end rests on the abutments, or on the box girder, as the case may be. Where the joists rest on the abutments *no anchor bolts* are provided. Where they rest on the box girder the connection is made by two ¾-in. bolts. The joists are not continuous over the box girder, but are cut in two pieces.

The ties are 7x10-in. oak, and are new and in first-class condition. The rails were well laid on iron tie-plates, and the guard-rails and guard-timbers are well secured and bolted. Except for one guard-timber and one stringer, the timberwork of the bridge is not seriously damaged, although the ties on the west half of the bridge are marked to a small extent by the derailed wheels that passed over them.

Track Alignment and Centrifugal Effect

The northerly track approaching the bridge from the east (the one used by the wrecked train) is on a curve of about 2° to the left for a short distance, and the outer rail is raised 3 in. above the inner rail. After the accident, for a distance of about 100 ft. east of the bridge the track was straight, and continued straight until opposite the middle of the most easterly girder, when it again curved in the same direction, crossing most of the bridge on a curve. While at least half of this straight piece of track can be accounted for by the lateral movement of the track on the bridge during the wreck, the whole of it cannot be so accounted for, and there must have been a flat place in the curve before the wreck. This alignment of the track would result in giving the engine a roll.

The force due to this roll, combined with the centrifugal force due to taking the curve again, would produce a heavy lateral thrust on the bridge nearly opposite the junction of the two girders on the north side of the bridge. (See view Fig. 4. The men on the track are about 15 ft. west of the junction of the two girders. Note that the rails are practically straight up to the joints this side of the men. The sag in the track and its displacement are evident.)

This combined force varies with the speed of the train. At high speed the length of the tangent is such that the two separate forces would probably act practically together. The swaying of the trains and bridge, as observed by people in the vicinity, is undoubtedly to a large extent due to this fact.

The sharp skew of the bridge and the consequent deflection of one end of the floor joists, which were supported by the girders, without a corresponding deflection of the other end where the support is the stone abutment, also tends to cause a roll or swaying motion irrespective of and in addition to the one caused by the above-mentioned short tangent between the two curves.

The track approaching the bridge from the east is on a down-grade, and there is no speed limit at this point. It is probable that speeds of 60 miles or more per hour were not infrequent at this point. The constant effect of long and heavy trains crossing this bridge many times a day at high speed must have tended to weaken it by the repeated lateral forces which it was called upon to withstand, and which its defective design provided no means of safely resisting, and which computations would have shown to be unsafe. The bridge was, in fact, weakening under these repeated forces, and cracks have for some time been developing in the wrought iron, until finally the combined thrust of the two heavy locomotives at high speed (probably at least 50 miles an hour) caused the weakest place to yield.

Damage to the Bridge

The most obvious conclusion on examining the bridge is that the cap-plate on the end column directly under the ends of the two north girders (Post 8) broke longitudinally and allowed the end of the box girder and the two north girders resting on the box girder at this point to sag (see view Fig. 7). This statement is the only one so far given as the reason for the wreck in the various reports that have been made. There are certain facts shown by bends in the iron of the bridge, however, which make this theory questionable:

(1) The westerly of the two north girders has a decided bend laterally to the north about 21 ft. west of the east end of the girder, and at the point where the first joist connects this girder to the box girder (see Fig. 9).

(2) Both north girders at the point where they connect to the box girder are shifted northward, about 2⅛ in. for the westerly girder and 3½ in. for the easterly girder, from the position they originally occupied on top of the box girder. The great lateral strain before the two ¾-in. bolts which fastened each of these girders to the box girder gave way is shown by the indentations in the flange angles of the girders made by the nuts of these bolts before finally shearing off.

Fig. 3. Steel Sleeping Car Wrecked by Striking Loaded Coal Car on Lower Track

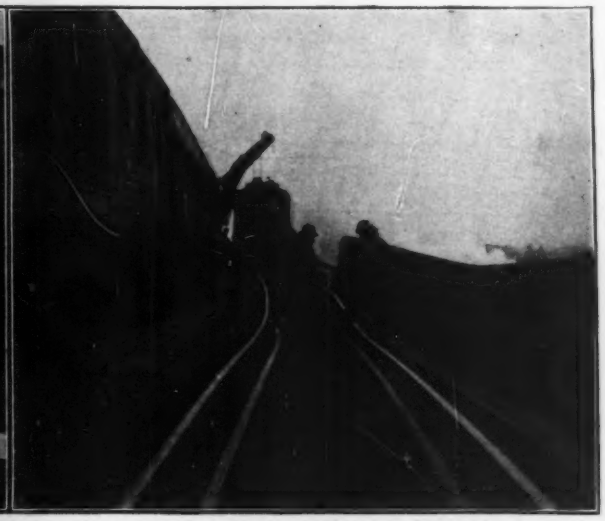


Fig. 4. View West along Track 4 on Bridge 43½ after Wreck

(3) The top of the box girder is also bent northerly between the second and third columns at the northeast end of the bent (Posts 7 and 6). The cross-section of the girder changes from a rectangle to a rhomboid, and the iron in the web-plates and flange angles is badly bent and cracked for several feet.

(4) An examination of the base of the first column (Post 8) shows that the two ⅞-in. anchor bolts on the south side of this column were pulled out of the masonry a maximum of $\frac{7}{16}$ in. The marks of the nuts on the steel, and the fresh break in the paint, indicate that this yielding of the anchor bolts was probably coincident with the accident.

(5) The second column (Post 7) is tipped about the same amount in the opposite direction, i.e., to the south.

The breaking of the bolts holding the two main girders to the box girders, the displacement of the main girders northerly, the deformation of the box girder, the direction of the movement of the end column cap, the bending of the box girder at this point after the cap-plate broke, and the pulling of the anchor bolts on the south side of this column, all indicate a heavy force applied in a northerly direction or toward the outside of the curve of the track. All of these actions might have resulted from the breaking of the cap-plate on the first column, although the force which moved the girders northward and broke their anchor bolts would indicate that the movement of the girder was first. If the cap-plate had broken first it is probable that the main girder would have remained bolted to the box girder, as the broken cap-plate would have hardly have provided resistance enough to tear this more solid connection loose. A more important consideration and really the fact that provides the key for the unlocking of the mystery is the bend in the main girder 21 ft. westerly from Post 8.

Bend in Northwest Girder

This bend was evidently the result of a lateral thrust in a northerly direction applied to the girder, as there is no mark of a blow on the girder. In order for this bend to have taken place, both ends of the girder must have been secured. If the cap-plate of the first column had broken first and allowed the ends of the main girders to sag and move in a northerly direction, due to the centrifugal force of the train, then the floor joists opposite this bend would have tended to hold the main girder in position at this point, as they were fastened to the box girder; consequently the bend if produced at all would have been in the opposite direction. It is this bend that makes the theory that the accident was due to the broken cap-plate untenable. It is evident that a great lateral force was applied to this girder through the floor joists, as they were the only parts of the bridge connecting to the girder near this point.

The joists, which are 15-in. heavy I-beams, had a shoe plate riveted to the ends that rest on the masonry, but without the use of any anchor bolts or any other positive connection. The joists opposite Posts 6 to 8 all moved bodily northward, the maximum distance being about 6 in. near the bend in the main girder. Considerable work had been done jacking up the girders and bridge floor at the time of my examination, and it is believed the actual movement of this point had been somewhat greater, although it could probably not have exceeded 9 in.

The bend in the north girder and the movement of the joists directed my attention to the box girder near Posts 6 and 7, and by crawling under the floor of the bridge the cause of these movements was easily seen. A section of the bridge at this point is shown in Fig. 5. The joists which rest on the abutment have their other ends resting on the box girder, and separate short joists run from the box girder to the main girder, except for the first 21 ft. at the easterly end, where the joists between the two girders are omitted. The joists were connected to the top of the box girder by two ¾-in. bolts in each one. This construction of the floor caused the greater part

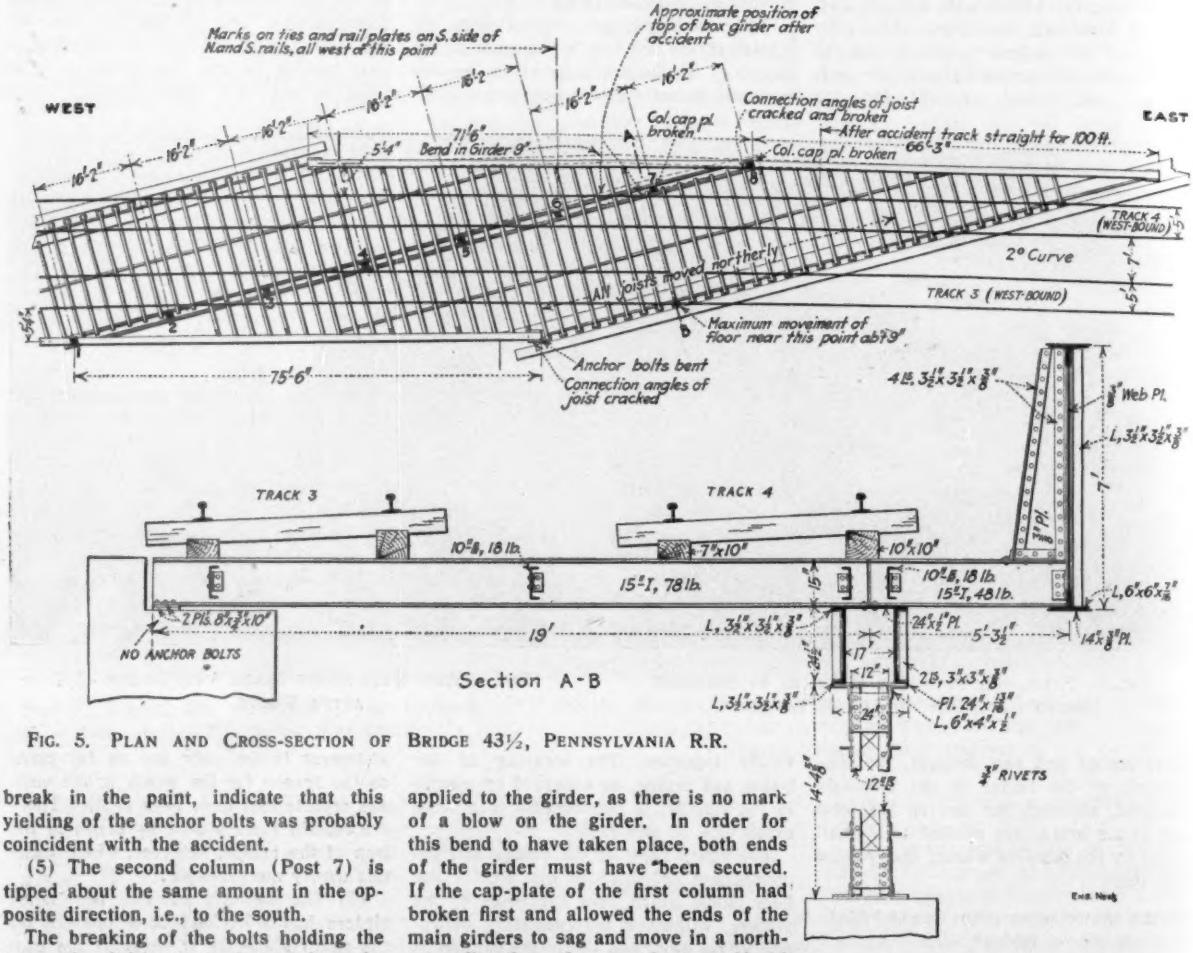


Fig. 5. Plan and Cross-section of Bridge 43½, Pennsylvania R.R.

of the load of the northerly track near the second and third columns to be carried directly by the box girder.

Box Girder at Post 7

Near Post 7 the box girder was badly crushed and bent laterally. The top was displaced over 9 in. northerly, and the top of the column displaced about 5 in. in the opposite direction (Fig. 6). The cap-plate of Post 7 was broken in exactly the same manner as the cap-plate of Post 8, and the connecting angles of the column and bottom angles of the main girder were badly bent, the latter being broken through at some of the bolt holes and the other bolts broken off. The deformation of the box girder at this point is shown by an approximate section in Fig. 6, and by photograph, Fig. 8.

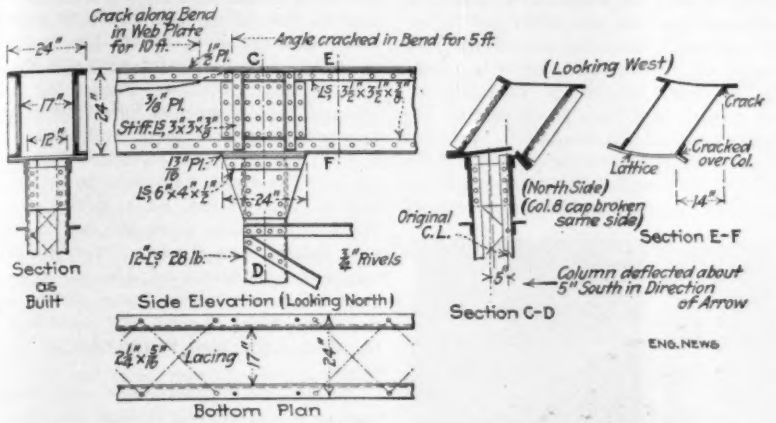


Fig. 6. Sketch of Damage to Box Girder over Post 7, Bridge 43½

Cause of the Failure

It is my opinion that the failure of the bridge started by the buckling of the webs of the box girder between Posts 6 and 7, the top of the girder being deflected northerly by the centrifugal force of the train. It is also my opinion that this action had been going on for some time, and that the wreck was only the climax of a gradual failure. This deflection would result in a movement of the track northerly, and a sagging of the track. The sharp bend and sag in the track would result in greatly increased centrifugal and impact stresses.

In support of this conclusion I would state that the most easterly joist that connects to the south main girder has an old crack in the bend of each of the angles connecting it to the girder. The anchor bolts connecting the east end of this girder to the abutment are *bent northerly*. There was no evidence of any appreciable movement of this girder during the wreck. These old cracks and bends are at the only place in the entire structure where any reasonably direct means are provided for resisting lateral forces, and the amount of work they were required to perform is attested by these cracks and bends.* The yielding at this point must have also been accompanied by the lateral deflection of the top of the box girder, as this was the only other means of resisting lateral forces, and its design was ill adapted for this service.

Referring to the section in Fig. 5, it is clear that there was very little load carried by the floor joists to the south abutment for trains on the north track near this section. The friction of these joists on the abutment was consequently a negligible quantity. The only means of resisting the centrifugal force of a train was the lateral stiffness of (1) the main girder, 71½ ft. long, without lateral bracing; and (2) the box girder, which had no stiffening diaphragms and was spliced over Post 6.

A few simple calculations at this point are instructive. The force necessary to deflect the main girder laterally a distance of 1 in. by a load applied at the point where the bend took place is as follows:

L = Span = 71 × 12 = 852 in.;
A = Distance load from far end = 50 × 12 = 600 in.;
E = Modulus of elasticity = 28,000,000;
I = Moment of inertia of girder laterally = 312.

The maximum deflection is,

$$d = \frac{F A (L-A)(2L-A)}{9 E I L} \sqrt{\tfrac{1}{3} A (2L-A)}$$

$$= 1 \text{ in.}$$

Therefore,

$$F = \frac{9 \times 28{,}000{,}000 \times 312 \times 852}{600 \times 252 \times 1104 \times \sqrt{200 \times 1104}}$$

$$= 854 \text{ lb.}$$

The maximum stress in the flanges of this girder produced by this force F would be

$$\text{Maximum moment} = \frac{F A (L-A)}{L}$$

$$= \frac{854 \times 600 \times 252}{852}$$

$$= 151{,}600 \text{ in.-lb.}$$

$$\text{Maximum stress} = \frac{151{,}600 \times 7}{312}$$

$$= 3400 \text{ lb. per sq. in.}$$

The angle between the box girder and the track was only about 15°, so that any lateral force on the track was largely a lateral force on the box girder and trestle bent, the actual component in this direction being 0.966 of the total force. Assuming now an engine crossing the bridge at a speed of 48 mi. per hr., with a maximum axle-load of 61,500 lb., which was the weight of the heavier driving-axles of the locomotives used on the wrecked train, the centrifugal force due to this axle-load on a 2° curve would be,

$$F_c = \frac{W v^2}{g R} = \frac{61{,}500 \times 70.4 \times 70.4}{32.2 \times 2865}$$

$$= 3300 \text{ lb.}$$

This centrifugal force, as has been pointed out, was greatly increased by the roll of the engine caused by the poor alignment of track, and also by the deflection of one side of the track where supported by the girder while the other side was supported by the abutments. An impact of 100% should in any case be added to this computed centrifugal force on account of the suddenness of the application of this force to the box girder, and it is probable that the actual impact was at times at least 50% greater.

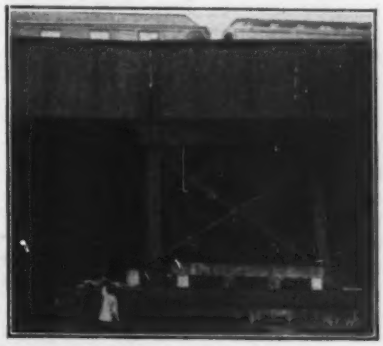


Fig. 7. Looking South at Posts 8 and 7

Considering the section of the box girder shown in Fig. 6, and assuming a lateral force applied to it at the top and the box girder held by bolts through the bottom flange angles, the horizontal shearing and resulting bending stresses had to be carried entirely by the web-plates. The depth of the web-plates below the top rivet-holes was 22 in. There were no tie-plates on the bottom of the box girder, so that the only resist-

*The end stiffener of the south girder and the joist with the cracked angles have been bent in a previous wreck, and the blow sustained by the girder was sufficient to break a hole in its web near the joist. This blow was in a southerly direction, and would not account for the anchor bolts being bent in the opposite direction.—C. A. W.

ance to lateral deformation at this point was the 2¼x⅜-in. lacing bars, which provided a small amount of stiffness, but could not have added over 10% to the strength of the web-plates alone. It is probable that the limiting stress for these webs bending parallel with the fiber of the iron was considerably below the elastic limit of good iron as usually determined, and this view is borne out by the cracking of the webs, wherever the bend was over 30°, instead of the fibers stretching. Assuming, however, the ordinary elastic limit of good iron or about 30,000 lb. per sq.in. as the stress these webs could sustain, and allowing 10% for the lattice bars, the length of girder necessary to resist the centrifugal force from the 61,500-lb. axle-load would be,

$$\text{Length in feet} = \frac{22\,Fcy}{1.1 \times 30{,}000\,I}$$

$$= \frac{22 \times 3300 \times 6 \times 8 \times 8}{30{,}000 \times 12 \times 3 \times 3 \times 2 \times 1.1} = 3.9$$

No allowance has been made for impact in this computation, and consequently the actual length necessary was probably at least 7.8 ft., which is slightly more than the distance between driving-wheels. It is evident from this computation that heavy locomotives at speeds of 50 miles or more an hour must have frequently strained this box girder beyond its elastic limit, and it probably had deflected laterally to a slight extent before the wrecked train approached the bridge.

As the box girder and main girder were connected by the floor joists, any lateral deflection would have been equal in both. A deformation of 1 in. laterally in this box girder would result in bending stresses in the web due to the resulting eccentricity of vertical loads; and for loads between Posts 6 and 7, this bending stress would be about 75% of that due to the corresponding centrifugal force. The vertical load also caused relatively large stresses in the box girder as a beam, but these are difficult of exact determination on account of the stringers and box girder being continuous over several supports; but as they occurred coincident with the lateral bending stresses they would materially reduce the lateral force which the girder could sustain. It has been shown that the force necessary to deflect the main girder 1 in. was only about 25% of the centrifugal force on one axle, and that a lateral deflection of 1 in. in the box girder would increase the web-bending stress over 75%; consequently no help to support the box girder could be expected from the main girders, and when the former once started to deflect laterally to an appreciable extent its destruction was certain.

The foregoing computations establish beyond question that the box girder between Posts 6 and 7 was strained to or beyond the elastic limit by heavy engines at speeds of 50 mi. per hr.

Having established the probable starting point of the wreck, a reconstruction of the various steps should be possible, for if any fact will not agree with the theory, the fault is with the theory. The engineer of the second engine of the freight which preceded the wrecked train said he felt something like a low joint when crossing the bridge. The deflection and settling of the box girder had probably started. The engineer of the first engine of the wrecked train felt a sudden sagging and then a rearing up of his engine, and he was thrown to the left, or toward the inside of the curve. Part of the wheels of this engine left the rails, being derailed to the *south* or inside of the curve. The experience of

FIG. 8. VIEW WEST ALONG NORTH FACE OF BOX GIRDER AT POST 7

the second engine was similar. The deflection of the girder having started by the centrifugal force would be continued and completed by the vertical load as previously pointed out, the girder as it crushed acting like a toggle joint to force the track and main girder to the north and the top of Posts 6 and 7 to the south. The northerly movement of the track, to an amount that must have been at least 6 in., would easily account for some of the wheels being derailed, as there must have been a dip as well as a lateral movement, and the derailment in such a case would be on the south side. There is a joint in both the most northerly rail and the stringer under it, within about 3 ft. west of the weakest part of the structure (Fig. 5), and a joint in the stringer under the other rail of No. 4 track about 5 ft. east of this section. These joints would undoubtedly have a good deal to do with determining the place where the bend in the rails would occur, and were at points which would facilitate the lateral movement of the track by the deforming of the box girder. The marks of derailment on the south side are all west of this point.

The sharp curve in the track and the dip would result in a very great impact load on the failing box girder as each wheel took the dip. As the box girder crumpled up and deflected northerly, the westerly main girder was pushed out of line and bent at the first floor joist connecting it to the box girder, which was 21 ft. from Post 8. In the meantime the columns of the trestle bent held firm. The lateral force on the main girder was finally sufficient to break the two ¾-in. bolts holding it to the box girder, and it moved bodily northward 2⅜ in., stopping when the bottom flange struck a rivet head, which made a dent about half the size of the head in the edge of the flange.

The two main girders were connected together at the top, and through the floor-beams and track at the bottom. The easterly girder probably broke away from its anchor bolts at the same time that the westerly one did, moving about 3½ in. north, and the whole of the track on the bridge must have shifted with the girders. Probably coincident with the breaking of the anchor bolts in the girders and the shifting of their load toward the edge of the box girder, the defective cap-plate on the column under this point broke longitudinally and let the end of the box girder spread and settle over the top of the column.

As the end of the box girder sagged under the weight of the main girders, the load on the adjoining column greatly increased and was sufficient to break the cap-plate exactly in the same manner as the end one. The deformation of the box girder was also increased by this settling, and the toggle-joint action was sufficient to start the two columns tilting, the end one tipping north and the adjoining one tipping south.

There is one other fact that sustains the foregoing theory of the accident. The joist which connects to the west main girder close to the east end, and which rests at the other end on the abutment, has the angles connecting it to the girder bent and pulled away from the girder, the angles being cracked in the bend. This joist is the only one connecting to the main girder until the one 21 ft. from the east end is reached, where the bend occurred. I believe it is impossible to account for the bends and cracks in these connecting angles if the first failure in the bridge was the breaking of the cap-plate of the first column.

THE DEFECTIVE DESIGN

In trying to demonstrate the foregoing theory and take the blame away from the

cap-plate and put it where it belongs, I do not wish to appear to condone or excuse such an amateur design as the column caps. If the columns had been turned at right angles so that the angles and gusset plates would have properly supported the parts of the cap-plate where the load was carried, this detail would not have been subject to condemnation, although it could have been improved. But as designed and built, with the loads from the two main girders carried on brackets only 1¼ in. thick and concentrated 2½ in. from the side of the column, this detail merits just condemnation.

The detail of the box girder, without stiffening diaphragms over the columns or at splices and the entire absence of tie-plates at the ends of laced sections, was not in accordance with good practice even 22 years ago.

The most serious defect of all, however, and a detail which should have merited especially careful consideration for a bridge on a curve and so great a skew, was the entire absence of lateral bracing. This defect could have been partially remedied by anchoring the floor joists to the abutments, but even this easily-provided precaution was omitted.

All of these defects in the original structure could have been remedied without interfering with traffic and with only moderate expenditure; in fact, the entire elimination of the curve on the bridge would not have been difficult. If these changes had been made, the bridge would have been lighter than would be built today for the traffic that passes over it, but not light enough to be unsafe.

Having set forth these faults in design it would be unfair to withhold credit for the excellent track construction over the bridge. The ties are of white oak dapped and well fitted over the stringers. The rails are 100-lb., supported by plates on every tie, and their excellent quality was shown by their carrying the train across the dip without breaking, although one of them sustained a permanent vertical set of about 6 in., and received the impact of the successive wheels as they took the dip. The guard-rails and guard-timbers were also in excellent condition.

The fortunate conditions or occurrences which prevented a worse wreck, which would have resulted from an entire collapse of the bridge, were the jamming of the main girder against a rivet head on the box girder after having broken loose from its anchor bolts and thus being stopped from entirely slipping off from the box girder; the holding of the anchor bolts of the columns throughout the accident, although two of them pulled up a short distance on the first two columns; and, finally, the rapid slowing of the train by the air brakes, thus reducing the impact and centrifugal force, the train being brought to a standstill in a distance of about 1000 ft. The effect of brake friction on the bridge would not be serious, as the design was much better adapted to resist longitudinal forces than either vertical or lateral ones.

As there were several old cracks in the iron of the bridge which might have been seen by close inspection, it seems as if the weakened condition of this structure should have been known. A detailed computation of the stresses in the various parts of the bridge would have been tedious and intricate and the final result only an approximation; but a few judicious computations which took account of horizontal as well as vertical forces would have shown an expert in a few minutes' time that the failure of the bridge was only a question of time unless properly strengthened.

FIG. 9. VIEW ALONG NORTHWEST GIRDER OF BRIDGE 43½ AFTER WRECK, SHOWING BEND

(The joint of the girders, over Post 8, is in the immediate foreground. The bend at the first bracket is about 20 ft. from the joint).

There are a few time-honored lessons to be learned from this disaster. The design of an important structure is only begun when the sections necessary for shears, bending moments, direct tension and compression are determined. The provision for secondary or elastic stresses, the supplying of adequate bracing and stiffeners so that the various members can perform the duty expected of them without distress, are of the greatest importance. The practice of using two bolts for a connection without considering the size and importance of the members connected, and the use of rule-of-thumb methods for the spacing and sizes of stiffeners, tie-plates, lattice bars, etc., without relation to the forces these parts have to resist, is unscientific and sometimes dangerous. Very few failures of important structures have ever been recorded where the fault was the insufficiency of the main members to sustain the loads for which designed, but some insignificant detail or secondary stress which was not considered was usually to blame.

The exacting and multitudinous requirements in the design of new structures on a system the size of the Pennsylvania R.R. might easily engross the attention of the officials who would otherwise discover existing weaknesses in old structures. The dimness begat by time and confidence born of years of service under working conditions take away the interest in poring over musty and dirty plans of old structures or climbing over greasy ironwork, until some accident like this one at Glen Loch disturbs the regular course of events. While consideration of the facts presented should cause every engineer in authority to endeavor to prevent a recurrence of any such disaster by greater carefulness, charity and justice both dictate that no condemnation should attach to the able members of the engineering profession who have built and maintained a railroad of the high degree of excellence of the Pennsylvania R.R., because some bridge designer 22 years ago failed to take into consideration the weight and speed that would be attained by railroad traffic today. Rather, all who have occasion to use and be familiar with this railroad must unite in praise for its excellent equipment and service and the great safety with which it carries its millions of passengers.

Sewage Pumping in Chicago during 1911 amounted to 19,280,000,000 gal. at the five pumping stations. The stations and their daily capacity are as follows:

	Gals.
95th St.	200,000,000
73d St.	180,000,000
Pullman	6,000,000
Kensington	5,000,000
Hegewisch	10,000,000
Total	401,000,000

The Use of Reinforced Concrete in Sea Water is discussed by a special commission appointed by the Government of the Netherlands to investigate the proposed reclamation of the Zuiderzee. This commission has presented a voluminous report, which is abstracted in "Le Genie Civil," for Nov. 30, 1912. The commission has carefully studied the resistance of concrete in sea water; it has taken full cognizance of all the tests which have been made, and has looked into a large number of structures which have already been built both in Holland and abroad. As a result of these, its conclusion is that no reinforced-concrete work has had sufficient life in sea water to permit of a definite decision in its favor. At the same time, they state that the results so far seem to justify its employ where proper care is taken as to its design and construction; for example, the mortar should be rich and the blocks should be allowed to age in air a long time before being placed in the ocean.

Wreck of a 175-Ft. Trestle by Braking Stresses.

On Nov. 25, 1912, a new timber trestle at Marshfield, Ore., collapsed while a logging train was passing over it. Six persons were killed in the wreck. The circumstances of the accident were quite unusual. An account prepared for us by Thos. Engelhart, of Marshfield, is given below. A photograph showing the appearance of the structure after the collapse is reproduced herewith.

The trestle was 104 ft. high above river bed. It had only been completed a very short time before the accident and the wrecked train was the second train that passed over it. The train which caused the accident consisted of a 60-ton Shay locomotive and three cars of timber. As only one member of the train crew survived, the facts concerning the occurrence of the accident cannot be determined with great certainty. It appears, however, that the train applied brakes just as it entered the trestle. Longitudinal bracing was either absent or very scantily provided in the structure, and therefore the drag of the braked train was too great for the longitudinal resistance, and the trestle was pushed forward, buckling ahead of the engine and tearing away at the rear.

WRECK OF 100-FT. TRESTLE AT MARSHFIELD, ORE., NOV. 25, 1912

The trestle was built of cedar. The successive stories being drift-bolted together. The cedar of this region splits easily and the connections therefore were probably a weak part in the make-up of the structure.

A Low Price for hydro-electric power is reported to have been made in Norway where a contract for 25,000 kw. for use in electrochemical industry is said to have been made at a price of $8.30 per kw. per annum.

Imhoff Tanks and Sprinkling Filters for Sewage Treatment at the Fulton County Almshouse, Georgia.

BY P. H. NORCOSS*

Fulton County Almshouse, near Atlanta, Ga., accommodates from 150 to 250 inmates. The stream which drains the grounds surrounding the institution is so small that it became necessary for the County Commissioners to install a treatment plant that would produce a well purified and practically stable effluent. Upon investigation it was decided to construct a plant consisting of a screen chamber, Imhoff tank, sprinkling filters and a sludge bed. Fig. 1 shows a plan and profile of the plant and the accompanying full-page illustration shows the various parts in detail.

This plant was completed in the summer of 1911, and immediately placed in operation. With the exception of one period, due to break-down of the water-supply pumps, when the plant stood idle for a couple of weeks, the plant has given excellent satisfaction, and has produced an effluent of excellent quality.

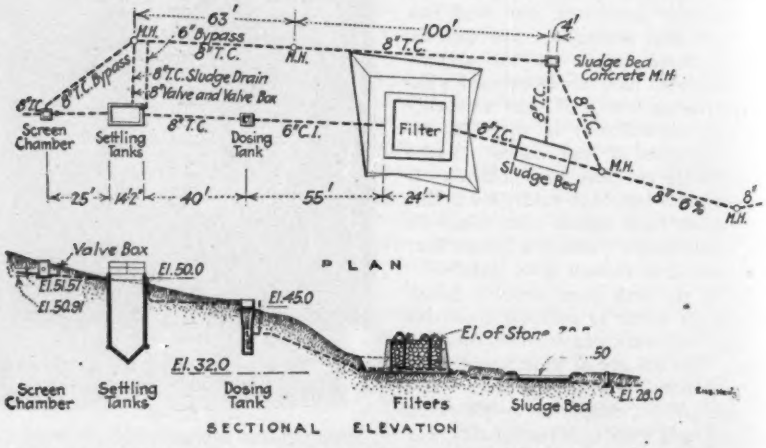


FIG. 1. PLAN AND PROFILE OF SEWAGE-TREATMENT WORKS FOR FULTON COUNTY ALMSHOUSE, GEORGIA

SCREEN—The sewage upon arriving at the plant first enters an open screen chamber 3x3 ft. in plan, containing an iron screen composed of ¼x2-in. rectangular bars, spaced 2 in. in the clear. The screen chamber is directly connected with the Imhoff tank.

IMHOFF TANK—The Imhoff tank is 9x11 ft. in plan, and has an inside depth of 17 ft. The time of the average flow of the sewage through the tank varies from 1½ hr. to 2½ hr. The sludge compartment is designed so that, if necessary, sludge can be stored in it for six months or longer.

SPRINKLING FILTER—The sprinkling filter is in one unit of an area of 0.11 acre. The sewage is discharged upon the filter from a dosing tank, using a 5-in. Pacific Flush Tank Co.'s sewage siphon, with a working head of 6 ft. at the nozzles. The Taylor square nozzles are used.

The stone filtering material has an average depth of 6 ft. The system of underdrains, consisting of 6-in. diameter half tile, discharges the sewage into a drainage sump in the center of the filter. The filter is surrounded by dry rubble masonry walls. A revolving copper hood and ventilator in the center of the filter gives additional ventilation and aëration to the stone medium. The outlet of the filter is trapped so that the air that passes into the filter through the ventilator cannot escape except through the crushed stone.

SLUDGE BED—A sludge bed is provided so that the sewage coming from the Imhoff tanks can be thoroughly dried out, and used for filling purposes.

GENERAL AND COST DATA—The plant was placed in operation late in the summer of 1911; it is now treating from 15,000 to 20,000 gal. daily. It is giving excellent satisfaction, the stone keeps clean, and the results are all that could be expected.

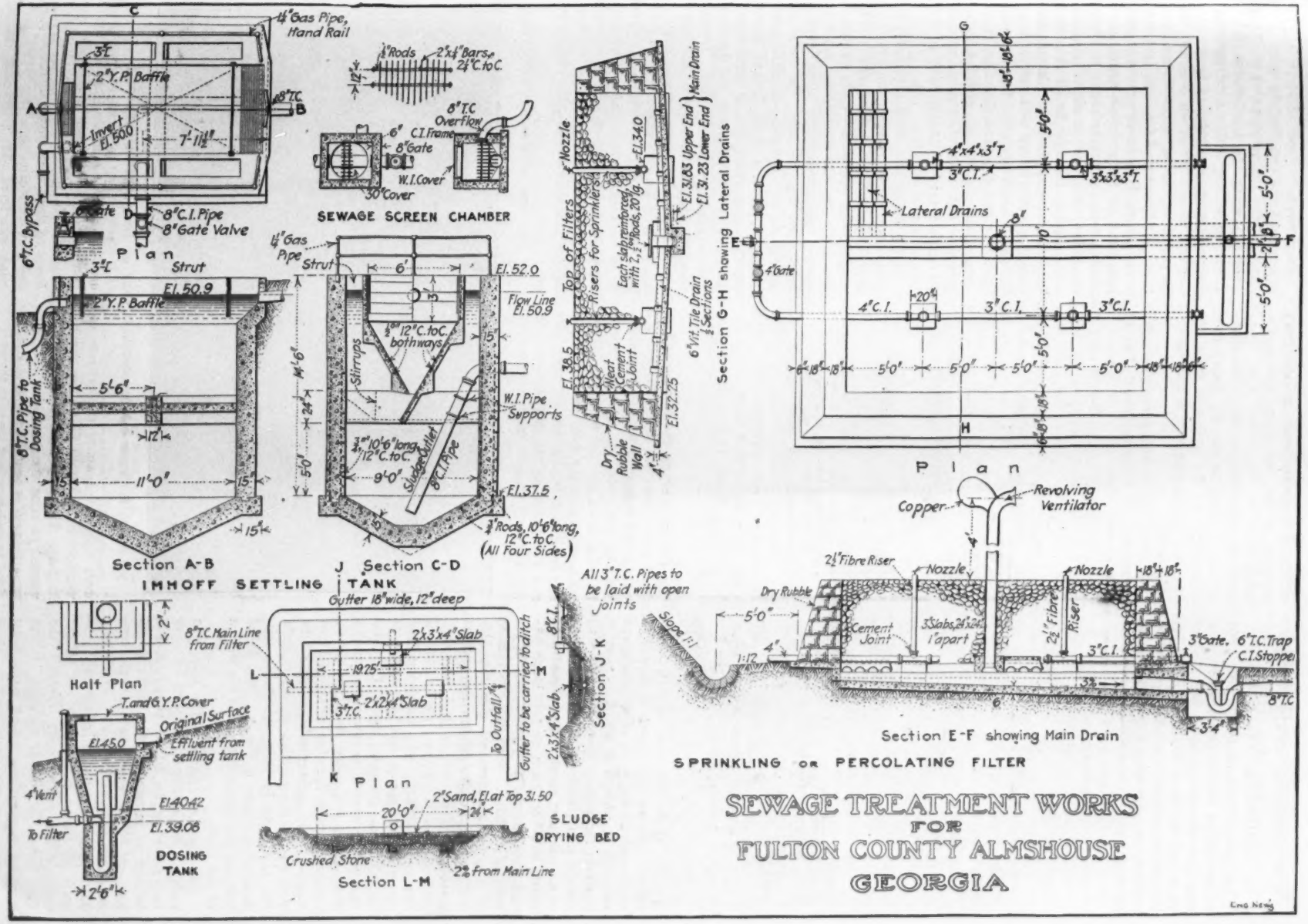
The plant was designed by Solomon-Norcross Co., Atlanta, Ga., and was built by the Dysard Construction Co., Atlanta, Ga., at the following cost:

Screen chamber and Imhoff tank	$820
Dosing tank	185
Sprinkling filter	1235
Sludge bed and manhole and pipe lines	584
Total	$2824

The total prices given include all connections between the component parts of the plant, which were made with 8- and 6-in. sewer pipe.

The plant is located about nine miles from the center of the city of Atlanta, and all material had to be hauled at least six miles from the nearest siding.

*Of Solomon-Norcross Co., Civil Engineers, Candler Building, Atlanta, Ga.


Plan
Section A-B
IMMOFF SETTLING TANK
Section C-D
SEWAGE SCREEN CHAMBER
Section G-H showing Lateral Drains
Plan
Section E-F showing Main Drain
SPRINKLING or PERCOLATING FILTER
Half Plan
DOSING TANK
Plan
Section J-K
Section L-M
SLUDGE DRYING BED
SEWAGE TREATMENT WORKS
FOR
FULTON COUNTY ALMSHOUSE
GEORGIA

The Accident to the Dam at Fort Angeles, Wash.

The accident to the dam of the Olympic Power Co., at Port Angeles, Wash., was described in our issue of Dec. 5, but since then we have obtained further information and an explanatory sketch, furnished at our request by Thomas T. Aldwell, Vice-President and General Manager of the company. It may be explained that the dam proper is supported at the ends in the walls of a rocky gorge some 35 ft. wide, and that work was in progress for putting down a cut-off wall through the gravel which fills the gorge to an unknown depth. The pressure of water, however, blew out this loose material, leaving the dam intact, but in the form of a bridge. With this explanation of the circumstances we give Mr. Aldwell's account of the construction and the accident.

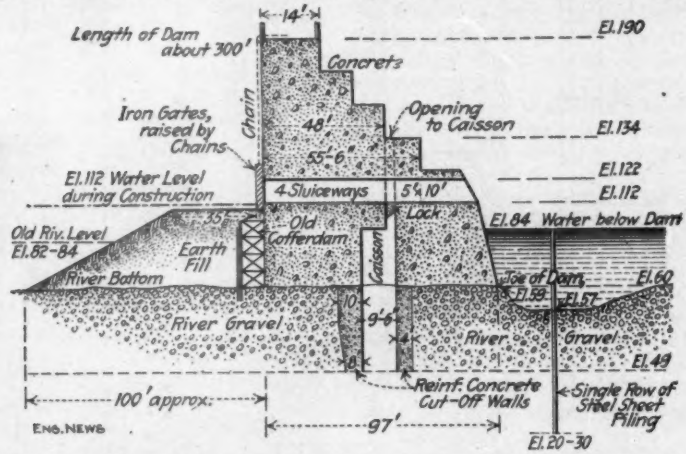


FIG. 1. CROSS-SECTION OF THE PORT ANGELES DAM, SHOWING THE CUT-OFF WALLS WHICH WERE BEING SUNK BELOW THE MAIN DAM WHEN THE LOOSE RIVER GRAVEL BLEW OUT (OCT. 30, 1912)

The Elwha River has a normal flow of about 1500 sec.-ft., and a maximum flood flow of 30,000 sec.-ft. has been known to occur. The Olympic Power Co. dam was built across a narrow gorge in this river about 2½ miles from its mouth, which is about 2 miles west of Port Angeles. The engineers in charge of the work on this construction started to build the dam early in 1911, this being constructed as shown in Fig. 1. They failed to make any tests whatever of the bottom of the river.

The main structure of the dam was built on the original river bed of sand and gravel at El. 60, as shown, and a caisson or square opening about 26 ft. long and 9½ ft. wide was left in the center of the dam with the view of running down cut-off walls of reinforced concrete, as shown in sketch, to cut off the seepage that might come through the river bottom in front of the dam. It was intended to run these cut-off walls down to impervious material, uniting them solidly with anchor rods to the main structure of the dam above and to the cañon walls on the sides. The work, therefore, proceeded on the main structure of the dam, so that the four sluiceways could take the river flow while this construction was going on in the caisson and above.

When the main structure was completed, work was started about May of this year to open up the caisson and go down to the river bed at El. 60, with the view to the examination of the bottom to see how much seepage (if any) existed. In going down into the river bed, curtain walls approximately 8 ft. thick (narrowing down to 6 ft.) on the upstream side and 4 ft. thick on the downstream side, together with heavy reinforced beams, were followed down in the caisson and work prosecuted until El. 60 was reached in July. The engineers in charge then wanted to raise the head, but the company thought it would be unsafe and decided to go lower, and went to El. 49.

Air pressure at from 12 to 15 lb. per sq.in. was employed, but the work was very slow and expensive, owing to all the material having to be brought down through a narrow lock. After reaching this point it was concluded to drive some Carnegie steel sheet-piling, weighing 35 lb. per sq.ft., across the cañon about 8 ft. ahead of the toe of the dam, as shown in the sketch. The pile-driver was erected and a row of piling driven right across more or less, and reached down to elevations varying from 20 to 30 ft. above the cañon; this was in 49-ft. lengths, datum. Owing to the water through the sluiceways interfering with the work of the pile-driver, and to the fact that the river was rising pretty fast, the gates were closed on Oct. 18, and the water gradually rose until it began to flow over the spillways at the north wing of the dam, at approximately El. 184.

In the meanwhile three investigations were made in the caisson, the air pressure being kept on, and no appreciable seepage was noticed from the upstream face at El. 49. Conditions were approximately satisfactory until along toward evening of Oct. 30, after the workmen had left the job. Evidence of bubbles and increased pressure were noticed below the dam, and within two or three hours the entire bottom gave way and the river washed through under the dam. Indications at the time were that the water started at the side of the cañon, along the line between the river gravel and the rock side. Whether this occurred at El. 60 or El. 49 between the rock wall and the cut-off walls is not known, nor is it yet known positively how much of the cut-off walls still remained after the blow-out.

At the time of the accident a large quantity of logs and débris in the upper lake formed by the dam came down into the cañon in front of the dam. A good many of them went under at the time of the blow-out, causing a jam which seriously interfered with a thorough investi

FIG. 2. VIEW OF DOWNSTREAM FACE OF DAM AFTER UNDERWASH

gation of the conditions of the river bed. Shortly after the accident, however, soundings were made at the face and toe of the dam and depths of 75 to 95 ft. were obtained by sounding. During the past 30 days, however, the depths have been reduced to 30 ft. and less by filling in with new river gravel.

The main dam is intact, as well as all the head works, penstocks, gate mechanism, the main structure of the power house, high-tension equipment and transformers, etc. The rush of water at the time of the blow-out struck the cliffs opposite the dam and turned at right angles and knocked out the 8-in. curtain wall at the south end of the power house (where it was ultimately intended to be extended) and filled the power house with loose gravel and water. The main switchboard was entirely destroyed, but being of remote control the high-tension 6600-volt switches and transformers, etc., for the control of the main units were not injured, so the damage was nominal on this part of the equipment. The main water-wheel units were in another room and were uninjured. The three 1000-kw. generators and the two exciters and the Lombard governor have since been cleaned out and can all be repaired in a short time at a comparatively small expense.

As it will take some time to remove the log jam and make exploration tests with drills for the cañon bottom, it will be some weeks before it can be decided as to the best method of procedure for the reconstruction.

Dead Typhoid Bacteria for Inoculation against typhoid are to be supplied to physicians, on application, free of charge hereafter by the Massachusetts State Board of Health. Three inoculations, giving a total injection of 2,500,000,000 of the dead germs are advised by the state authorities.

Failure of a Reinforced-Concrete Theater in Course of Construction, Cincinnati, Ohio

By Clifford M. Stegner*

A moving-picture theater in the course of construction for Dr. Carl Behymer, at 3550 Eastern Ave., Cincinnati, Ohio, was completely wrecked at about 3:20 p.m. on Dec. 10, 1912, without sufficient warning to give the workmen a chance for flight. Of the ten men employed on the structure at the time, four escaped unhurt, five were injured and one was killed.

The proposed building was about 31 ft. wide, 98 ft. 6 in. long and one story high, with the floor on the street level. The lot had a drop of about 25 ft. toward the rear, as indicated by the cross-section in Fig. 1 and the view in Fig. 2. The floor and first-story brick walls were supported on reinforced-concrete beams and girders.

The roof consisted of wooden trusses spanning the distance between the brick side walls, which was about 29 ft. in the clear.

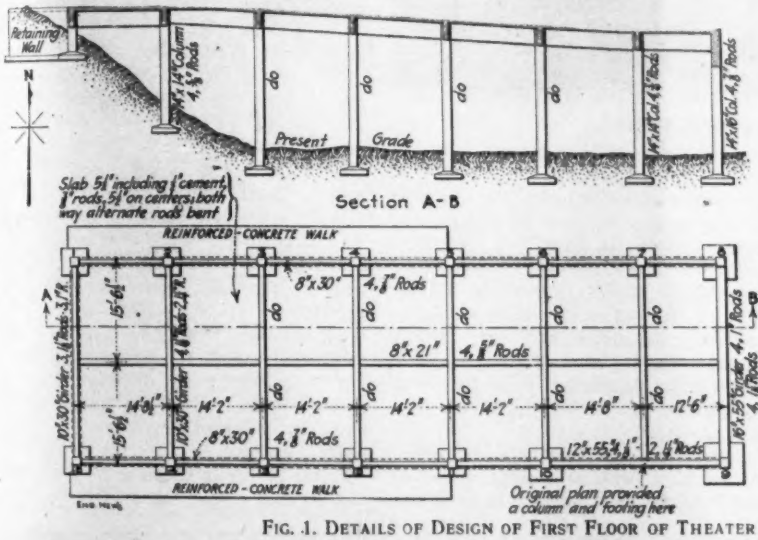
The floor slabs were approximately square, 5½ in. thick, of which the upper half inch was cement finish with ½-in. square twisted reinforcing bars placed about 9 in. on centers spanning both ways. The structure was figured for a live load of 80 lb. to the square foot, using unit stresses as follows:

Twisted steel in tension 20,000 lb. per sq.in.:
1:2:4 portland-cement concrete in direct compression, 600 lb. per sq.in.
1:2:4 portland-cement concrete in bending extreme fiber, 700 lb. per sq.in.
1:2:4 portland-cement concrete in shear, 65 lb. per sq.in.
Steel in shear, 10,000 lb. per sq.in.
Steel in compression, 10,000 lb. per sq.in.

*Engineer, Provident Bank Bldg., Cincinnati, Ohio.

The floor framing as built with dimensions of structural members, is shown on the revised plan (Fig. 1). The original plan provided a column under the east wall between Col. 8 and 9, which was omitted in the actual construction, because of a trunk sewer at this point. The 8x30-in. spandrel beams with four ⅞-in. square twisted rods on the 10.5- and 13.5-ft. clear spans were changed to a 12x55-in. girder with four 1⅛- and two 1¼-in. square twisted rods on a 25-ft. span. The footing under Col. 9 was increased from 5x5 ft. to 6x6 ft., and that under Col. 10 from 4x4 ft. to 5x5 ft. With these exceptions, which were approved by the local Building Department, the actual framing was in accordance with the plans submitted for a permit.

The original drawings were made by a Cincinnati architect with the assistance of a capable engineer, who designed all structural numbers and wrote the specifications. After the bids were opened the owner entered into an agreement with a local contractor, G. W. Custer, to revise the architect's plans and specifications and construct the building for a sum considerably less than the low bid. This action, repudiating the work of the architect and his engineer, was followed by a refusal on the part of the owner to pay the fee for the original drawings. The owner's action, however, was not sustained in court, where it was shown that the contractor (and architect No. 2) had traced the original structural design which was submitted under his name in obtaining the building permit, and the owner was therefore ordered to pay the first architect's bill for professional service.



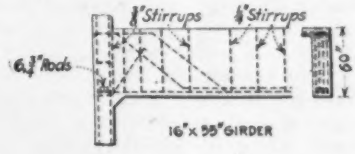


Fig. 1. Details of Design of First Floor of Theater Which Collapsed

G. W. Custer (architect No. 2 and contractor) a carpenter by trade, sublet the reinforced-concrete work, exclusive of the forms, to a cement contractor named Walter Worthman, who had practically no experience in reinforced-concrete construction. The forms were prepared by Custer in accordance with his copied plans, using lumber that was intended for subsequent service in the roof of the building. The reinforced-concrete work was completed without competent supervision about Nov. 9, after which the brick walls were built on the new concrete before any forms were removed. The next procedure was the removal of all forms excepting the bottoms of beams and girders and the supporting uprights. This did not give sufficient lumber to

FIG. 2. VIEW OF COLLAPSED BUILDING

complete the roof, and the remainder of the form work was ordered down by the general contractor and architect. All went well until the supports were pulled from the girders framing into Col. 9, supporting the 13-in. brick walls (about 22 ft. high) and the roof. With the removal of these supports came the collapse on Dec. 10, just one month after the pouring of the concrete.

The temperature during this month dropped considerably below freezing on several days, and the general conditions were not at all favorable for the hasty removal of the supports. This, however, was not appreciated by the inexperienced men in charge of the work. Another evidence of ignorance plainly shown in the wreck was the careless placing of tension rods for the beams and girders. The architect's detail for the 16x55-in. girder on the north end of the building shows the U-bars arranged in pairs which would have held the tension rods in vertical planes with ample opportunity for the surrounding concrete to develop the adequate grip. The U-bars in the wreck show a change from this detail, as can be seen on Fig. 3. Instead of having one wing of each U extending between the tension bars, both wings are outside of all the tension rods. There was no apparent effort to maintain the tension rods in proper position or permit the concrete to surround the bars.

In the 16x55-in. girder on the north end of the building with four 1-in. and four 1⅛-in. rods carrying its portion of the floor and roof with a 22-ft. brick wall, all tension rods were jammed closely together, with no intervening space for concrete as far as visible. The 16-in. width, with eight tension bars in two layers, would have permitted a spacing of 4 in. on centers with 2 in. from the center of outside bars to the face of girder. The wreck reveals six bars in a horizontal space of 9 in. and the two remaining bars immediately above. Had the double U-bar been used as shown on the detail, embracing the middle and outer bars on alternate sides with horizontal stubs to maintain the parallelism in two horizontal planes, the difficulty would have been obviated.

Four 1-in. and four 1⅛-in. square twisted bars, with a working stress of 20,000 lb. per sq.in. on a 30-ft. span uniformly loaded in a homogeneous reinforced-concrete beam require an average transmission of grip equal to

$$\frac{9 \times 20{,}000}{15} = 12{,}000 \text{ lb. per lineal foot}$$

To be exact, the grip per lineal foot will vary from zero at the center to 24,000 lb. at the support, for a uniformly loaded beam. It is unreasonable to expect eight bars bunched together, as was done in this girder, to develop the adequate grip. As soon as these bars were subjected to strain, any slight movement would break the small bond in the center of the girder between the points where the tension bars begin to rise to the top of the girder, thus necessitating a development of all the grip in the ends. An analogy may be drawn between a beam so constructed and a plate-girder with the rivets omitted in half the length of the bottom flange.

All girders visible after the collapse showed this same defect. The 10x30-in. girder across the building framing into Col. 7 with four 1⅛- and two 1¼-in. rods showed six rods side by side in the bottom (plainly visible in Fig. 3) with no opportunity for developing grip in over half its length. While there is no doubt that the immediate cause of the collapse may be attributed to the unseasoned condition of the concrete, there is a question as to whether the concrete failed in compression or in grip. Even if the concrete had been thoroughly hardened, the weakness caused by the careless placing of the steel would have impaired the safety factor to such an extent as to make the structure dangerous.

This collapse is the first reinforced-concrete failure in Cincinnati. Engineers and architects have taken much pride in

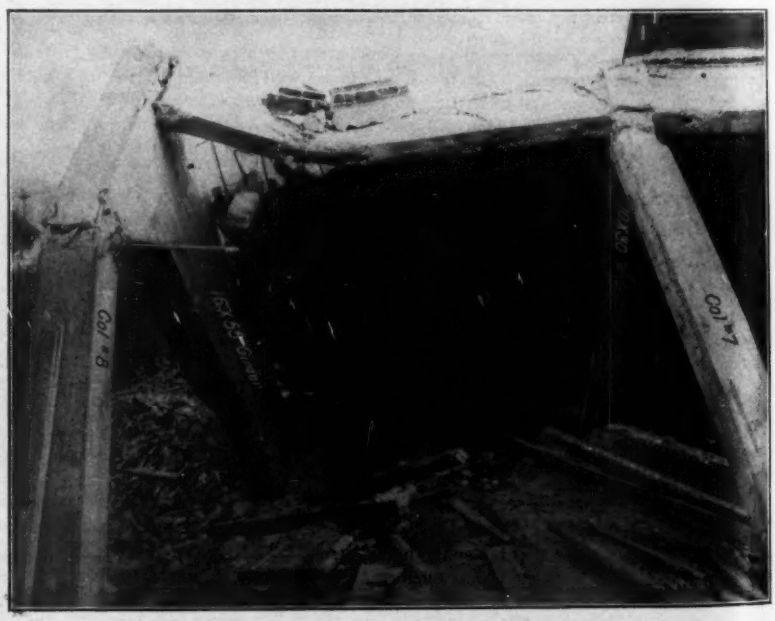


FIG. 3. VIEW OF PORTION OF COLLAPSE

our local record of immunity from such accidents. It is reasonably certain, however, that the structure would have been safely completed had the original architect and his engineer been permitted to superintend the construction instead of trusting to men with no engineering knowledge or practical experience. While the loss of a life and the injury to others is regretted, it is probable that the toll would have been larger had the structure held until after completion, and filled by an audience.

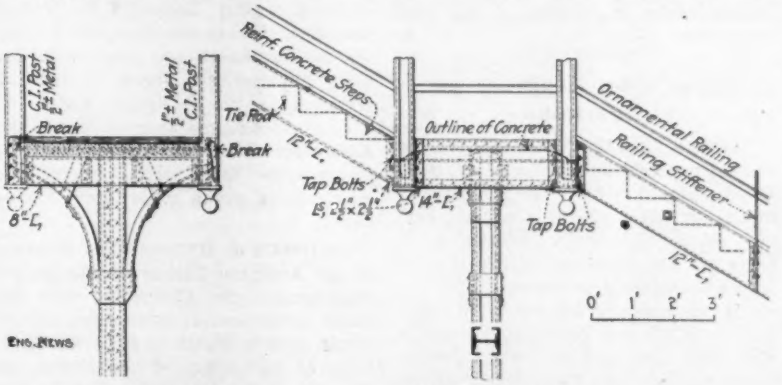
Failure of Stairway to Elevated Railway Station, Brooklyn, N. Y.

A portion of the stairway leading from the Nostrand Ave. station of the Atlantic Ave. elevated line of the Long Island Ry. out of Brooklyn, N. Y., collapsed at 7 p.m. on Dec. 19 and killed one man, the only person who was on the staircase at the time. A train had just left the station, but most of the passengers from it had descended by another stairway, so it was most fortunate that the one which collapsed was not crowded, as it often is at this time of night. Few witnesses of the accident have so far appeared, and those who claim to have seen it do not seem to have a very clear idea of the occurrence, but an examination of the structure the morning after the collapse revealed some features of the design which are of interest. The drawing accompanying this article was made by our draftsman at the site and has not been checked up by the drawings of the structure now in the possession of the railway company.

The Atlantic Ave. improvements to the Long Island R.R. were completed in 1905 (ENGINEERING NEWS, May 22, 1902, p. 419). They consist of alternate sections of subway and elevated structure entering Brooklyn at the Flatbush Ave. station. The Nostrand Ave. station is on a two-track elevated structure extending from Nostrand to New York Aves., with stairway entrances at both streets, the eastbound and westbound tracks being approached by stairways on opposite sides of Atlantic Ave. The four stairways at the station are of similar design, a design which was used at some other stations along the same line. The stairway that failed leads from the eastbound track at the New York Ave. end of the station.

The stairway consisted of two flights of steps, with an intermediate short platform supported by a single central column. The stairs proper had wooden plank treads, but were of concrete, reinforced with twisted-steel rods, spanning between stringers, of steel channels, which carried each flight of the structure between the platform and the top platform and ground, respectively. Tie-rods, ¾ in. in diameter, passed through the concrete steps and the supporting stringers about every 4 ft. and kept the stringers from spreading.

The stringer channels were turned inward and the whole bearing of the concrete steps was on the bottom flanges of the stringers, about 2¾ in. wide. A detail of the connections at the platform is given in the accompanying sketch. The main stringers of the upper flight, where the collapse occurred, were framed at the top into the fascia stringer of the platform, but at the lower end they framed into the cast-iron post at the corner of the platform. These posts, in fact, form the connecting link between the different parts of the stairway, and carry on their upstairs face the upper flight stringer, on their downstairs face the platform stringer, and on the inside a channel fascia girder which serves to prevent the spreading of the two posts of the platform. These cast-iron posts are about 5 in. square and are of metal which appears to be less than ½ in. thick.



END ELEVATION SIDE ELEVATION

DETAILS OF PORTION OF ELEVATED RAILWAY STAIRWAY WHICH FAILED, BROOKLYN, N. Y.

The portion of the upper flight which fell is shown dotted. Drawing made from sketches at the site.

All the connections to them are made with ½-in. tap-screws.

The railing was of ornamental ironwork connected to the cast-iron posts and also stiffened by narrow plates rising from the stair stringers.

In the collapse the stringers of the upper flight, which were about 18 ft. long on the slope, tore out at their four connections and dropped the entire stairway to the sidewalk below. The railing was left in place, though there are signs of its having been pulled partly out on one side of its upper end. At the lower end of the stringers, where they were connected by an angle to the cast-iron post (riveted to the stringer and tap-screwed into the post), the cast iron was broken out of the posts, leaving jagged holes in both posts, and the pieces, with their tap-screws, remained attached to the angle connections on the stringers. The breaks in this cast iron are covered with rust and seem to be very old, as though cracks, if not full breaks, had been present for some time. On the other hand the upper connections show new breaks, on one side through the steel angle connections, on the other by the pulling out of the rivets in the corresponding connection.

The entire weight of the upper flight was carried on the four connections—the two lower ones each carrying four tap-screws into a cast-iron post. If, as it seems probable, the cast-iron posts have been cracked for some time, the weight must have been carried by the upper connections, by the rusty and fragile connection at the posts and by the considerable support given by the railing stiffeners acting as hangers. The concrete floor of the intermediate platform must have been integral with the upper flight concrete steps, but there is no indication of a reinforcement connection between the two. The break in the concrete at the upper face of the platform is so far under the flooring that it cannot be examined readily, but as far as can be seen its thickness is only about 3 in., which would not add very much to the supporting ability of the stairway.

The entire structure, staircases and platform, is in an advanced state of rusting and is decidedly in need of paint. In one place on another of the stairways at the same station, it was possible to remove about half of the projecting part of a filler plate, which was corroded to a state of structural worthlessness. There seems to have been a decided lack of inspection. One of the cast-iron posts in another of the stairways shows a marked crack through one entire showing face, but evidently this had not been considered worthy of correction by the railroad, although obviously the stability of the entire staircase depended upon the connection to the cast-iron post and the strength of that post.

A number of daily papers have called

the collapse "another concrete failure." So far as can be determined now, the concrete had nothing to do with the failure except to add to the weight that the cast-iron column had to carry. In the débris which was found after the accident, the concrete seemed strong enough to serve its purpose, i.e., to span a 6-ft. opening between the girders. It should be noted, however, that several reinforcing rods were found showing pronounced corrosion, though in no case to the point of failure. This corrosion, however, is indicative of the general state of the structure and not a sign of initial failure in the reinforced-concrete steps. If these had failed first, it is entirely probable that the stringers would have remained in place.

The Public Service Commission is interesting itself in the design of the stairway, inasmuch as it is a fairly common one on the elevated railways of the city. Already orders have been given to prop up the remaining stairways of the Nostrand Ave. station with 12x12-in. timbers. A coroner's inquest, with thorough engineering advice, is promised by the local authorities.

Notes from Engineering Schools

CORNELL UNIVERSITY—A relic of the first subway built in New York City, some 40 years ago, has just been presented to this University. This is a circular boring shield additionally interesting in being the first specimen of this type of boring device used in America. The old shield was recently dug up by the contractors of the new Broadway subway in New York City, and the Public Service Commission for the First District of the State of New York, authorized its gift to F. C. Beach, son of the inventor. Mr. Beach, in turn, presented it to Cornell. This subway was described in ENGINEERING NEWS, Feb. 15, 1912.

UNIVERSITY OF WISCONSIN—Instruction by correspondence is now given in many engineering courses at this institution, including 16 courses in electrical engineering, eight in mechanical drawing, 24 in mechanical engineering and 16 in structural engineering. Among the related subjects of importance to engineers are found mathematics, chemistry, geology and mineralogy. These subjects are usually given chiefly by lectures and illustration, and others are largely laboratory work, such as shop sketching and topographic surveying. A recent addition is a course in microscopic petrography. University credit is given for many of these courses to properly qualified students. This work is under the Extension Division of the University, with headquarters at Madison.

PURDUE UNIVERSITY—The school of civil engineering announces an engineering conference of county surveyors, city engineers, county commissioners and other public officials at Lafayette, Ind., Jan. 6-18, 1913. At this time the school offers a short course of illustrated lectures, laboratory observation and conference on drainage and water power, concrete construction, cement and concrete, materials of construction, highway engineering, railway bridges, public accounting, contracts and specifications, sanitation of school houses, sewerage and water supply.

This course will be divided in two parts. One will extend from Jan. 6 to 18, and will be strictly technical, being intended for city engineers, county surveyors and engineering contractors; the second division will last one week, from Jan. 13 to 18, and will be less technical, aiming to familiarize those attending with results rather than the methods of obtaining results, and intended particularly for county commissioners, road supervisors, public-health officials, etc. No fees are charged for the courses.

TULANE UNIVERSITY—The private collection of books, papers, and drawings of the late Maj. Benjamin M. Harrod have been given to the University Library for the benefit of the Department of Civil Engineering. Major Harrod, as president of the American Society of Civil Engineers, and as a member of the Mississippi River and Isthmian Canal Commissions, had a rare opportunity for accumulating works not ordinarily available.

UNIVERSITY OF ILLINOIS—The members of the American Society of Mechanical Engineers at the University, with the heads of the several engineering departments, gave a dinner to Dean W. F. M. Goss, of the College of Engineering, on Dec. 13, at the University Club in Urbana, as an expression of their appreciation of the honor paid him by his election to the presidency of the American Society of Mechanical Engineers. Among the guests present were the members of the Council of Administration of the University of Illinois and Dean Charles H. Benjamin, of Purdue University.

On Dec. 18, a special Engineering Convocation was held to permit the general faculty and the students in the College of Engineering to express their appreciation of the honor paid Dean Goss. Brief addresses were made by President E. J. James and Prof. A. N. Talbot, after which Prof. Ira O. Baker presented to Dean Goss a beautifully engrossed testimonial signed by representatives of the faculty and the various engineering organizations at the University of Illinois.

Fire Damaged 15 Locomotives in the New York Central roundhouse at Summerville, N. Y., on Dec. 18, following an explosion in the boiler room. There were 12 men working close to the scene of the accident, but none were injured. The loss is given in press reports as about $150,000.

A Broken Brakebeam is blamed for the derailment and wreck of a freight train on the New York, New Haven & Hartford R.R., near Westport, Conn., on Dec. 14. The beam is thought to have dropped down and dragged for two miles before it finally caused the derailment. Three freight cars were destroyed and the tracks were reported blocked for an hour, but no one was injured.

An Oil-tank Explosion at the Indianapolis, Ind., yards of the Cleveland, Cincinnati, Chicago & St. Louis Ry., on Dec. 18, caused the death of two workmen and minor injuries to several others in the vicinity. The wrecked tank was one of the three tanks used to store crude oil for starting the fires in the locomotives. All three tanks were buried in the ground as a safety measure and when one of them sprung a leak it was necessary to drain the oil off and uncover the tank to make repairs. Two boiler makers were then sent to fix the leaks and had partly finished their work when the explosion came. It is supposed that combustible gas had occupied the tank when the oil was removed and that this was ignited either by the repair torch flame or by sparks from a pipe, which one of the men was smoking.

A Grade-crossing Accident occurred, at Ashtabula, Ohio, on Dec. 16, when a trolley car, containing thirteen passengers beside the motorman, was struck by a heavy coal train. Eight of the passengers were killed and the others on the trolley car were injured.

The collision took place at the point where the Ashtabula Rapid Transit Line crosses the tracks of the Lake Shore & Michigan Southern Ry.

A Butting Collision between two Chicago, Rock Island & Pacific passenger trains occurred on Dec. 16, near Chickasha, Okla., and resulted in one death and twenty persons injured. A peculiar thing about the accident, according to newspaper accounts, was that the southbound train was in the act of taking a siding to give right-of-way to the northbound train, when it was struck. Both locomotives were badly damaged and the smokers on both trains were telescoped.

Immunization Against Typhoid Fever. or inoculation designed to attain that end, is to be offered by the Department of Health of New York City free of charge on and after Jan. 1, 1913. Inoculations will be made by the inspectors of the Health Department at the homes of applicants, or at the Central Office of the department upon requests approved by the attending physician of the person to be treated. Cultures will also be supplied free to physicians for administration. It appears from a circular issued by the department that the inoculating material employed will be sterilized typhoid cultures. In this circular the department states that nearly all authorities now agree that inoculation against typhoid infection "reduces by three-quarters the number of cases of typhoid fever occurring among persons who have been so immunized." It also stated in the circular:

As at least 10% of the cases of typhoid fever occurring in New York City are thought to be due to contact, immediate or indirect, with a preceding case in the same locality, and not to infected water or milk, it is hoped that widespread immunization of the members of all such families will sensibly reduce the occurrence of typhoid fever in New York City.

The Westport Accident, on the New York, New Haven & Hartford R.R., on Oct. 3, last, is the subject of a comprehensive report by the Interstate Commerce Commission, issued on Dec. 7. The report calls the attention of railway managers to the frequency of accidents on large systems as well as small ones; on well managed roads as well as poorly managed ones; on railways protected with the most approved block signal systems; all which accidents in the last analysis are due to the fallibility of the human element. The report states:

As a result of this investigation it is evident that the recommendations made in the report on the accident near Bridgeport, Conn., July 11, 1911, apply equally in this case. The commission is satisfied that the neglect to comply with the recommendations in its report on the Bridgeport wreck was largely a contributing cause of the Westport accident. The recommendations of this commission are not mandatory

Railroad officials testified that there had been a stiffening up of discipline, but this did not seem to reach cases of speed in excess of that allowed by the rules at bridges where speed is limited by the rules; for there was evidence that at the bridge at Westport speed rules were habitually violated, even after the accident near this point.

To meet the requirements of a situation disclosed by the Bridgeport wreck—similar in all respects to the accident under consideration—no new devices have been installed, or seriously investigated, nor have any attempts been made by this railroad to even experiment with devices intended for the purpose of meeting these emergencies.

The whole result of such consideration as officials of this railroad have given the subject is a pessimistic hopelessness, indicated by testimony that "We are at our wits ends," etc. The operating vice-president, when baked what hope he saw of being able to accomplish anything to prevent the recurrence of these accidents, answered that he knew of nothing that would prevent absolutely such recurrence.

The readway and track conditions in the vicinity of the accident are good, and the construction of the crossover was substantial. All tie renewals are made with creosoted ties, and on these ties tie-plates are used, as well as screw spikes. At the crossover practically all the ties were new and screw spikes were used.

The investigation further developed that there were no speed restrictions governing passenger trains except at specified points, which are covered by signals and rules, and passenger trains are expected to make up time when late.

Excessive speed as a factor deserves serious consideration. The remarkable increase in speed and weight of trains within recent years, and the crowding of tracks and terminals caused by movement of the enormously enlarged volume of railroad traffic, have greatly increased the duties of employees and multiplied the chances of error on their part.

In a recent accident investigation made by our chief inspector of safety appliances it appeared that the general inspector of transportation of one of our largest railroad systems said: "Excessive speed is the cause of 75 to 80% of the catastrophes in the last few years."

The report also contains a long argument in favor of automatic train stops.

Preliminary Plans for Water Purification Works for Ottawa, Ont., prepared by Hazen & Whipple, New York City, were approved by the Provincial Board of Health of Ontario, on Nov. 23, 1912. In its general arrangement the plant is similar to one discussed (but not recommended) in a report by the same engineers, dated Oct. 5, 1910 (see Eng. News, Nov. 10, 1910, p. 521), but by direction of the city authorities the capacity has been increased by 40%, from 25,000,000 to 35,000,000 Imp. gal. (or to 42,000,000 U. S. gal.). Water would be pumped from the Ottawa River to coagulating basins, then passed through mechanical filters, disinfected by hypochlorite of lime when thought necessary, and then flow to a pure water reservoir of 6,000,000 Imp. gal. capacity. The intake would be north of Lemieux Island, above the Canadian Pacific bridge. To guard against anchor ice two separate intakes would be provided. To quote from Mr. Hazen's report:

One of these is through a basin, or forebay, of considerable size, through which water will enter on the downstream side only, with the idea of excluding as far as possible the frazil. The other intake is a 60-in. pipe extending to deeper water. Boilers are proposed in the pumping station on the island to furnish steam to fight ice if it occurs. The first mentioned intake, being short and entirely accessible, can be treated with steam at the screens under most favorable conditions.

The conditions in the river will be studied during the approaching period of anchor ice, and it is the intention to make any improvements in the design now presented, that may be suggested or grow out of this experience.

It will be possible to maintain the supply in case of complete stoppage of both intakes by anchor ice for several hours from water held in the plant and pure-water reservoir, allowing time for a channel to be opened and ice deposits cleared. This reserve will also serve in case of temporary interruption of the electric power used for pumping, and will serve until steam can be raised in the boilers and a steam pump put in service.

The pumps would be of the centrifugal type, electrically driven, with a capacity of 36,000,000 U. S. gal. a day. Sulphate of alumina would be used as a coagulant, with soda ash or lime (probably the latter) to make up for such deficiencies in alkalinity as occur. It is expected that 5 to 8 lb. of hypochlorite of lime per 1,000,000 Imp. gal. will be sufficient to disinfect the filtered water, compared with 100 lb. now used on the untreated Ottawa River water. The conduit from the filtered water reservoir to the main pumping station at Queen St., would comprise a tunnel 2250 ft. long, from the Island to Oregon St. This tunnel would be in limestone rock and after being lined with concrete would have a cross section equal to a circular conduit 7 ft. in diameter. From the end of the tunnel a 6-ft. steel pipe, surrounded by concrete, would extend for 2400 ft. to the pumping station. The estimated cost of the works outlined, and minor accessories not mentioned, is $1,100,000.

It may be added that the drainage area of the Ottawa River above the proposed intake is 34,623 sq.miles; its estimated mean flow 42,000 cu.ft. per sec.; and that the flow seldom falls below 10,000 cu.ft. The population on the drainage area does not exceed three per square mile and the total population in places of 4000 and over is only 20,839 or less than one per mile.

Plans for the Battleship "Pennsylvania" have been completed and bids for its construction will be opened on Feb. 18, according to recent press dispatches from Washington, D. C.

The dimensions of the new dreadnaught are: Waterline length, 600 ft., overall length, 608 ft.; beam, 97 ft. 0½ in.; draft, 28 ft. 10 in.; displacement, 31,400 tons. The boat is designed for a speed of 21 knots an hour and her armament is to consist of twelve 14-in. guns and four submerged torpedo tubes with a torpedo defense battery of twenty-two 5-in. guns. Her water line armor plate is to be 16 in. thick.

Oil-burning boilers of the water-tube type will furnish steam to the driving engines. It is reported that the decision as to whether turbines or reciprocating engines are to be used for propelling the big boat, has been reserved until the bids have been examined.

Grading Work, to cost over $13,000,000, is under consideration by the city of Los Angeles, Calif., and a preliminary survey and estimate have been prepared by W. E. Barrett, engineer for the Midway Gas Co., of Los Angeles, and H. M. Dougherty, of J. G. White & Co.

Five different projects are covered in the estimate, of which four represent different sections of the work, which could be regarded as units in case it was not desired to do all the work at once. The fifth plan suggested includes these four separate sections at a material reduction in expense from what would be required for the same work if done in four units. The items of the estimated cost of this fifth plan are given in the following table:

Excavation, 26,859,600 yd.	$6,084,057
Purchase of dump	1,000,000
Municipal Work	
Street work	643,497
Sewer and mains	96,790
Retaining walls	75,000
Bridges	.....
Maintenance of traffic	60,000
Miscellaneous	254,400
Buildings	3,495,772
Contingencies, 5 per cent	580,476
Interest during construction	696,571
Engineering plans and supervision	240,238
Total	$13,226,801

It is proposed to do the excavating by means of steam shovels and drag-line excavators, as being the most practical and economical method under the circumstances. Because of the difficulty of disposing of the excess water and because of the severe destructive effects of the material to be handled upon the many necessary relay pumps and pipe lines, the hydraulic method of excavating is discountenanced.

The entire sewer system in the affected area would have to be relaid and no salvage value is placed on the present installation. The water mains would also have to be relaid, but a fair salvage value is anticipated for the cast-iron water pipes now in use. The estimate involves the repaving of all streets in the regraded area with a 6-in. concrete base and asphalt wearing surface, with concrete sidewalks, curbs and gutters, making a surface that can stand heavy traffic.

The estimate above given was made at the instance of the Bunker Hill Razing and Regrading Association to determine the probable cost of removing portions or all of the hills bounded by Hill St., Sunset Boulevard, Main St., Figueroa and Fremont Aves., as an alternative to the driving of street tunnels under the same district. The engineers estimated that the entire hilly portion could be reduced to a grade approximating that of the choice business district at the cost noted above for project No. 5. A probable return of $5,000,000 was also predicted through the enhancement in value of the dumping ground where the excavated material would be wasted.

Electrolytic Extraction of Copper Ore as carried on in Norway, is described in the following note (Dec. 14 issue "Mining and Engineering World") by Chas. A. Holder, Consul General at Christiania, Norway:

For several months a company at Aamdal, Norway, has been successfully extracting copper from the crude ore by an electrolytic process invented by Victor Hybinethe, a Norwegian engineer, who has patented the process in Europe and the United States. The Aamdal works have proved so successful that plans are now under way for increasing the output to 3 tons of metallic copper per day.

The treatment, which is done at the mine and thus results in enormous shipping economies, consists in leaching the crushed ore with a solution of sulphuric acid which dissolves out the copper; a strong current of electricity is then passed through this solution and the pure copper is precipitated.

Experiments with copper pyrites from the Orkla and Sulitjelma mines, in which much foreign capital is invested, have been equally successful, and as a result will probably be treated by the Hybinethe process in the future. The ores were formerly shipped to Germany and Sweden, respectively, owing to their refractory character and to the lack of proper Norwegian reduction works, but of late the Sulitjelma Co. has not been able to mine with any profit by this plan owing to the costs of transportation. The new process will, therefore, mean a great deal to the copper industry of Norway.

A Riveted Rail Joint, with thermit-welded base, is being used by the United Ry. & Electric Co., Baltimore, according to the "Electric Railway Journal," Dec. 21, 1912. The fishplates are 32 in. long by 1 in. thick and snugly fit the contour of head and base of rail leaving minimum space beween web and plates. Both rails and plates are of the same high-carbon steel and are punched with ten $1\frac{1}{8}$-in. holes on 3-in. centers. The joint has been applied to about 1000 7-in., 103-lb. girder-section rails. These are undercut about $\frac{1}{8}$ in. to provide a $\frac{1}{4}$-in. space at the base of abutting rails to assist in the welding process. The rivets are driven by a crew of four men, it requiring 30 min. per joint; the welding gang also has four men and takes 15 min. The total cost has averaged $6.69 per joint.

Personals

Mr. C. C. Tinkler has been appointed Western representative of the MacArthur Bros. Co., Contractors, with headquarters at 1001 Chronicle Bldg., San Francisco, Calif.

Mr. Frank L. Neall, Assistant Chief of the Bureau of Highways, Philadelphia, Penn., has resigned. Mr. Neall has had charge of the street-cleaning department.

Mr. S. Baldwin, of Des Moines, Iowa, has been appointed Division Engineer of the Trinity & Brazos Valley Ry., at Teague, Tex., succeeding F. A. Pollak, resigned.

Mr. M. E. Johns, Superintendent of the New York, Susquehanna & Western R.R., at Jersey City, N. J., has resigned. He is succeeded by Mr. A. B. Shafer, Trainmaster at Stroudsburg, Penn.

Mr. W. S. Bake, Assoc. M. Am. Soc. C. E., Division Engineer of the Pere Marquette R.R., at Traverse City, Mich., has been appointed Trainmaster of the Petoskey division at Traverse City.

Mr. T. A. Sweeney, Assistant Superintendent of the Chicago Great Western R.R., at Chicago, Ill., has been promoted to be Superintendent, succeeding Mr. J. A. Gordon, resigned, as noted elsewhere.

Mr. James C. Travilla, formerly Street Commissioner of St. Louis, Mo., has been appointed Engineer in charge of the improvement of the highways of Tarrant County, Tex., to be carried out at a cost of $1,000,000.

Mr. W. H. Molchior, Trainmaster of the Chicago, Milwaukee & Puget Sound Ry., at Missoula, Mont., has been promoted to be Superintendent of the Rocky Mountain division with headquarters at Three Forks, Mont.

Mr. J. A. Gordon, Superintendent of the Chicago Great Western Ry., at Chicago, Ill., has been appointed General Superintendent of the Pere Marquette R.R. Mr. Gordon was formerly General Superintendent of the Cincinnati, Hamilton & Dayton Ry.

Mr. M. B. Snow, Assistant General Superintendent of the Michigan Central R.R., has resigned, effective in January, to become Secretary and General Manager of the Princess Manufacturing Co., Detroit, Mich. Mr. Snow has been with the Michigan Central R.R. since 1898, when he entered the railway service as a car checker.

Mr. M. H. Hovey has withdrawn from the signaling department of the joint engineering staff serving the Wisconsin railroad and tax commissions, to serve as consulting engineer for a group of interurban electric railways in the State of Indiana in connection with an extensive block signaling installation. Mr. J. N. Bidwell has been promoted to the position made vacant by Mr. Hovey's resignation from the Wisconsin staff.

Mr. O. T. Waring, Superintendent of the Atlantic Coast Line Ry., at Florence, S. C., has been appointed Engineer of Roadway, with headquarters at Savannah, Ga., succeeding Mr. T. S. Tutwiler, who has been assigned to special work. Mr. Waring was graduated at the University of Pennsylvania in civil engineering in 1902. Shortly afterward he began his engineering work with the Baltimore & Ohio R.R. At the end of a year he was promoted to Assistant Division Engineer, and a short time later went to the Atlantic Coast Line as Assistant Engineer. In 1907 he was Assistant Superintendent of the Charleston & Western Carolina R.R., but returned to the Atlantic Coast line within a year as Roadmaster.

Mr. Frank H. Alfred, M. Am. Soc. C. E., former General Superintendent of the Cincinnati, Hamilton & Dayton Ry., and recently Assistant General Manager of the Pere Marquette R.R., has been promoted to be General Manager, succeeding Mr. William Cotter, resigned. Mr. Alfred was for three years (1902-1905) Chief Engineer of the Pere Marquette. He received an engineering education at the University of Michigan and Ohio State University and entered the railway service as a rodman on the construction of the Columbus, Lima & Milwaukee R.R. in 1887. After a short time as Resident Engineer of the same railway he became Assistant Engineer of the Norfolk & Western R.R. in charge of the field work in the construction of the Columbus, Ohio, terminal. Later he was Assistant to the Chief Engineer of the Hocking Valley R.R., and Engineer of Maintenance-of-Way of the Wheeling & Lake Erie R.R. In 1905 he was Manager of the Canadian White Co., Montreal, Que.

Obituary

Henry England Grimm, Assoc. M. Am. Soc. C. E., was killed by being run over by a motor truck in the streets of Chicago, Ill., Dec. 12. Mr. Grimm was 35 years old.

Frederick J. Horswill, M. Am. Inst. M. E., a mining engineer of Oakland, Calif., was killed in a motor-car accident near San Miguel, on Dec. 17. While riding with his three-year old daughter his motor car plunged over a precipice. Mr. Horswill was instantly killed, but the child, who was clasped in his arms, was unhurt by the fall.

William J. Vaughn, Professor of mathematics and astronomy, Vanderbilt University, died at his home in Nashville, Tenn., Dec. 16, aged 78 years. He was graduated from the University of Alabama in 1857 and was Professor of mathematics there from 1860 to 1865. He founded the school of engineering at his alma mater in 1881. Since 1886 he had been a member of the faculty of Vanderbilt University.

William Haddon Marriott, an architect and engineer of Baltimore, Md., died Dec. 18. The early part of Mr. Marriott's engineering experience was obtained in railway construction in the West. After going to Baltimore he took up architectural as well as engineering work and was associated with the late Charles H. Latrobe, M. Am. Soc. C. E., in the design of the Calvert and St. Paul St. bridges in Baltimore. He also designed several prominent churches and residences in the city.

Engineering Societies

COMING MEETINGS

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 26-28. Annual meeting at Chicago, Ill. Secy., C. O. Reed, Urbana, Ill.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 30-Jan. 6. Annual meeting at Cleveland, Ohio. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Jan. 14. Annual meeting at New York City. Secy., W. R. Ingalls, 505 Pearl St., New York.

AMERICAN WOOD PRESERVERS' ASSOCIATION.
Jan. 21-23. Annual convention at Chicago, Ill. Secy., F. J. Angier, B. & O. RR., Baltimore, Md.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 21-23. Annual meeting at New York City. Secy., W. W. Macon, 29 W. 39th St., New York.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 28-30. Annual meeting at Montreal, Que. Secy., C. H. McLeod, 413 Dorchester St. West, Montreal.

Washington Society of Engineers—At the annual meeting in Washingotn, D. C., on Dec. 17, the Society elected the following officers for the coming year: President, Frank Sutton; Vice-president, William Bowie; Directors, W. A. McFarland, F. W. Albert, John Hanna, F. C. Boggs, A. L. Baldwin and J. H. Holmes; Treasurer, C. F. Jeansen, and Secretary, J. C. Hoyt.

Canadian Society of Civil Engineers—The annual meeting of the Society is to be held, in Montreal, on Jan. 28-30, and it is expected that the Society's new building at 176 Mansfield St., will be available for this meeting. Secretary, C. H. McLeod, 413 Dorchester St., West, Montreal, Que.

Brooklyn Engineers' Club—The annual meeting and banquet were held at the club house in Brooklyn, Dec. 19. The chief event of the evening was the award of the Alfred T. White prize ($50) for the best paper of the year. This was awarded to John B. Stein for a paper, which was published in our issue of last week, on the topographical bureau of Brooklyn. The officers elected for 1913 were James W. Nelson, President and Joseph Strachan, Secretary.

Eng. Lib.

Engineering News

Issued Every Thursday. Hill Publishing Company.

NEW YORK, DECEMBER 26, 1912

Price, 15 cents, $5 yearly. To Canada $7. Foreign $8.

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Table of Contents Announcement

GENERAL LIBRARY DEC 28 1912 UNIV. OF MICH.

THROUGH the courtesy of an advertiser who relinquished this front cover, we are permitted to use the space ourselves for this announcement.

Beginning with the next issue the editorial index, at the left of this page, will appear as a "Table of Contents" and occupy the whole of page 1. It will give not only the contents of the issue but a synopsis of each article that will indicate its character clearly to busy readers.

Individual items will be set in a size and form convenient for clipping and pasting on library cards for future reference.

We enter the house not by the back or side door, but by the front. The cover of a publication is the front door which, when opened, should reveal all that is inside, or indicate where it may be found.

There was some thought of using the front cover itself, but this seems impracticable. Nothing is more unattractive from an artistic standpoint than a table of contents, so we have set aside a prominent page which will be equally convenient for this purpose.

We shall run attractive advertisements on the front cover.

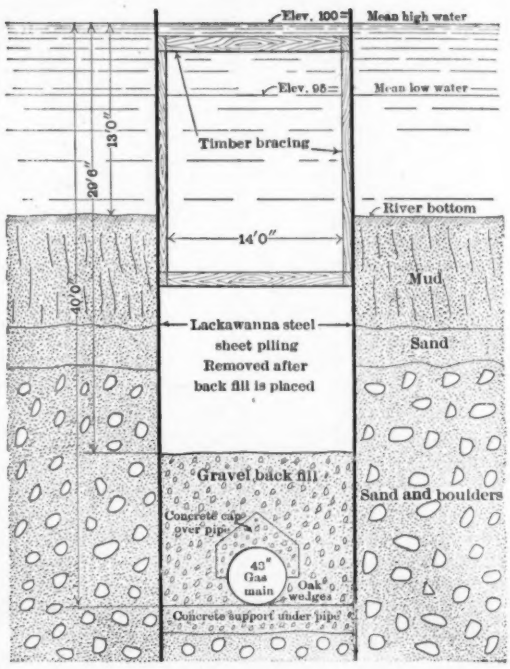
Engineering News

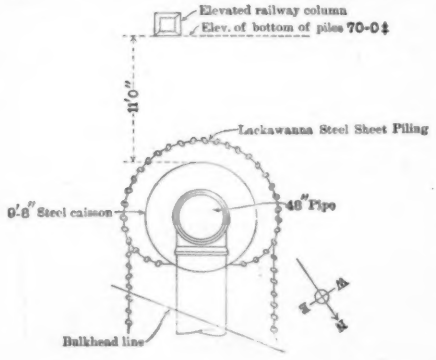
The part played by Lackawanna Steel Sheet Piling in laying the big Gas Mains under the Harlem River

In laying the 48-inch main, mentioned in our advertisement of last week, steel caissons were sunk on each side of the river, and stand-pipes inside of these connected with the main under the river. The cofferdams in which the main was laid had to be built sectional and successively, because the great amount of shipping and the current at this point prevented closing off more than half the river at one time. As built, the cofferdams were 14 feet wide, the first section extending out 130 feet from the Manhattan end, the next 143 feet farther to the center of the river and the third was continuous from there across the north half of the river. A typical section is shown.

The method of procedure as described by Mr. C. C. Simpson in his paper read before the American Gas Institute, was to drive one cofferdam, pump and dredge out the solid material to desired grade, build concrete pipe rests at regular intervals, lower two caulked pipe sections at a time onto the concrete supports, caulk the remaining alternate joints under water, place concrete protection blocks over the pipe line, back-fill the trench with gravel, and then pull the Lackawanna Sheet Piling for re-use in the next cofferdam.

The 45-foot piling bars were driven by a steam hammer and on an average to four feet below the pumping grade, penetrating without difficulty, sand and boulders which afterward proved troublesome to remove. The strong tide necessitated strong cross bracing to keep the sheet piling in shape.





The building of the caisson for the stand pipe on the Manhattan end developed an unexpected difficulty. As the cutting edge neared final position, a slight crack and settlement of the street surface near an adjacent elevated railway column became apparent. Further settlement was effectually prevented by driving a tight ring of Lackawanna Steel Sheet Piling around the caisson and to about 6 feet below its final position as indicated in the smaller diagram.

The general scheme of crossing was the same for the two 36-inch mains as far as the piling requirements are concerned, but both of the latter mains were laid in the same trench.

The successful outcome of this work evidences the superiority of Lackawanna Steel Sheet Piling in submarine excavation projects and the data above offers an example of the record we keep of Lackawanna Piling jobs so that our engineers can be of greatest assistance to prospective customers. Tell us when you are figuring on using steel sheeting and we will cite what Lackawanna Piling has done under similar conditions.

Ask for our Bulletins.

LACKAWANNA STEEL COMPANY

General Sales Office and Works: Lackawanna, N. Y.

NEW YORK BOSTON BUFFALO PHILADELPHIA PITTSBURGH CLEVELAND CINCINNATI CHICAGO DETROIT ST. LOUIS ATLANTA SAN FRANCISCO

45

If You Don't Care

what the results may be, any specification for process or material will do.

Have you considered the preservative treatment of the timber going into coal trestles, platforms, roof trusses or flooring?

You will double the life of the structure when you double the life of the wood. Timber properly protected against decay will last indefinitely.

Timber fully exposed in the air merits different treatment than ties, poles or piling.

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Pumping the timber full of some substance will serve no more useful purpose than filling one's system with any old medicine.

Effect follows cause.

While an incidental problem in your varying specifications—with us the preservation of structural timber is a matter of more than twenty-five years of continuous experience.

You can get the benefit of our study—of our experiments—of our experience.

To every client, to every user goes a full measure of the Service that has made *Surface Treatments with Avenarius Carbolineum* (brush, spray or open tank) *recognized as the standard in wood preserving circles.*

The product of the factories, Avenarius Carbolineum, is chemically the best wood preserving oil known.

The product offered you is *preserved wood*—Avenarius Carbolineum is the agent—the Service is the medium, combined they insure wood successfully preserved against decay.

Your problems get the attention of trained men if you address

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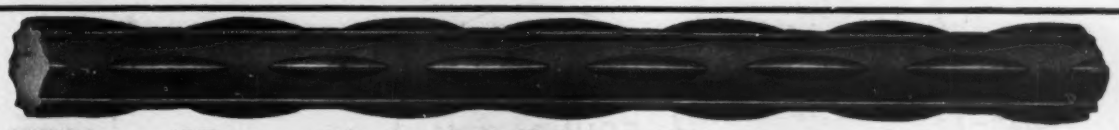
512 Prairie St. Milwaukee, Wis.
121 Front St. Portland, Ore.

SERVICE Avenarius CARBOLINEUM



Why You Should Use Havemeyer Bars

To Concrete Engineers and Contractors

Before deciding upon the type of bar to be used, the question of COST usually receives some consideration. The **cost of reinforcement** for a structure will depend on the following items:

Item 1. **Actual total cost** of the metal required, **delivered on the job.** The bar which weighs the least per lineal foot for a given area will require the **least possible amount of metal.** By using **Havemeyer Bars** you are reducing your total metal cost to a minimum, without sacrificing area, as **Havemeyer Bars weigh the same as plain bars. ("Every Pound Pulls").**

Item 2. **The cost of bending, fabricating and handling** is about **one-third** the **total cost** of the reinforcement in place. This cost will vary, more or less, in different classes of work under different conditions, and is entirely a labor cost. **Havemeyer Bars** can be bent, fabricated, and handled with maximum economy. This statement is based on the **actual experience** of a **great many contractors** in ALL CLASSES OF WORK.

All Havemeyer Bars are rolled from **New Billet Steel,** both in Chicago and Pittsburgh districts. Stocks in principal cities.

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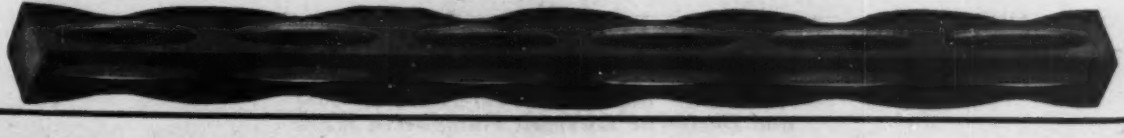
"Every Pound Pulls"



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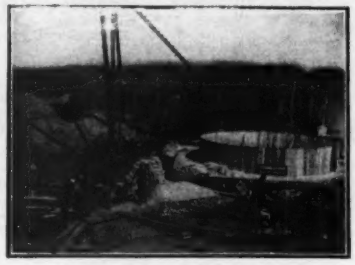
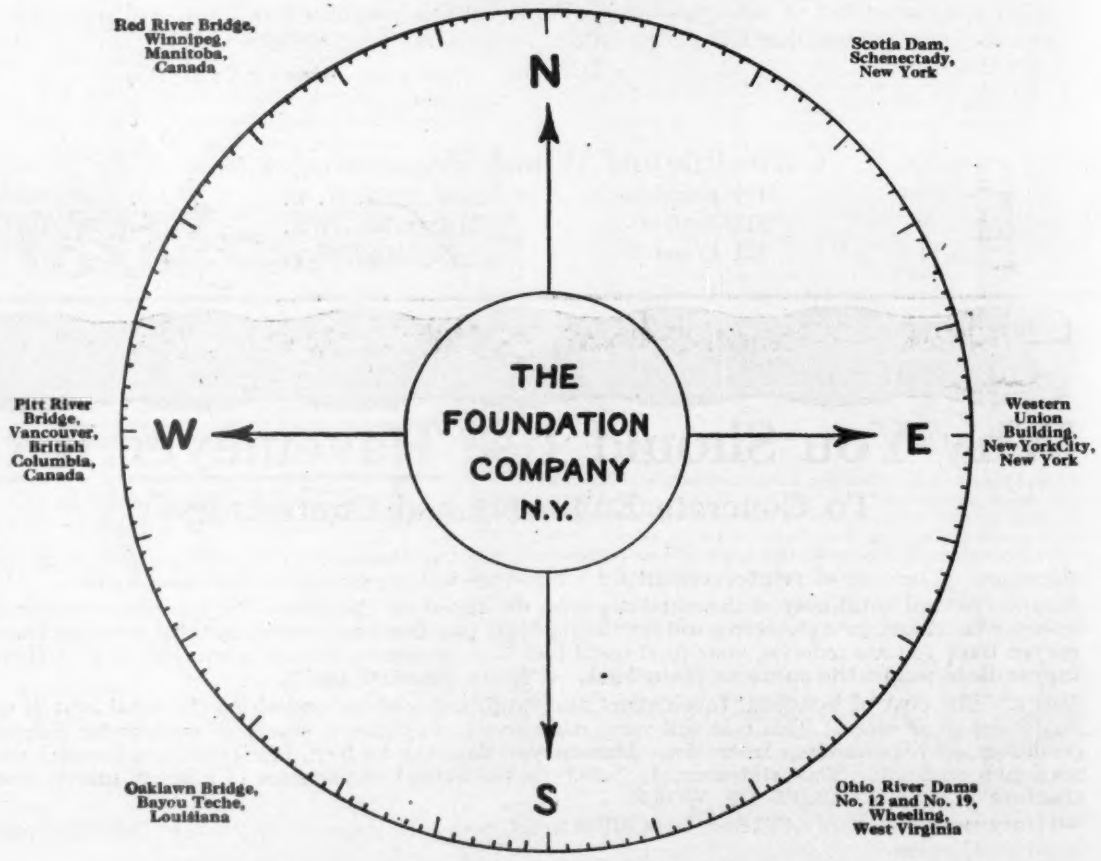


St. Albert Shaft,
Edmonton, Alberta, Canada


Red River Bridge, Winnipeg, Manitoba, Canada
Scotia Dam, Schenectady, New York
N
THE FOUNDATION COMPANY N.Y.
W
E
S
Pitt River Bridge, Vancouver, British Columbia, Canada
Western Union Building, New York City, New York
Oaklawn Bridge, Bayou Teche, Louisiana
Ohio River Dams No. 12 and No. 19, Wheeling, West Virginia

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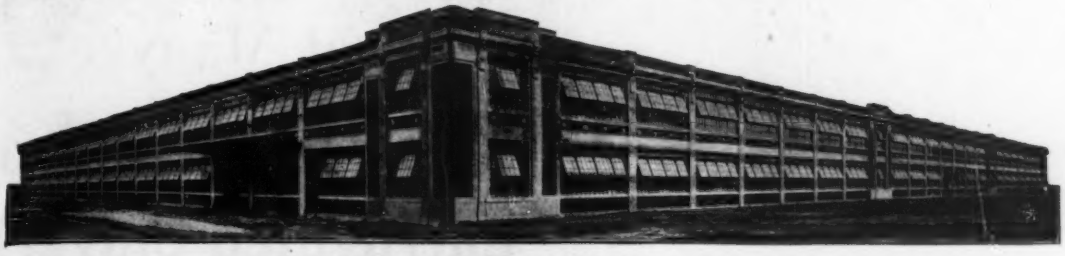

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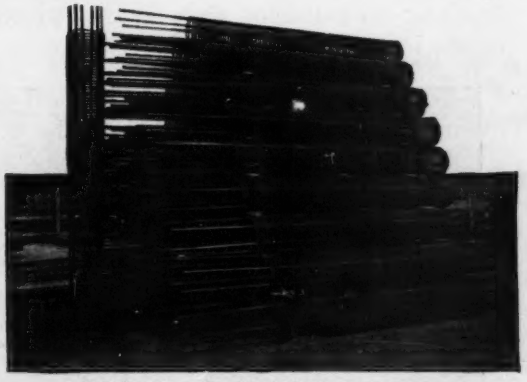
Flat Ceiling Construction, Continental Motor Mfg. Co., Detroit.



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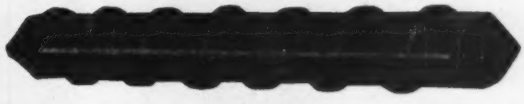

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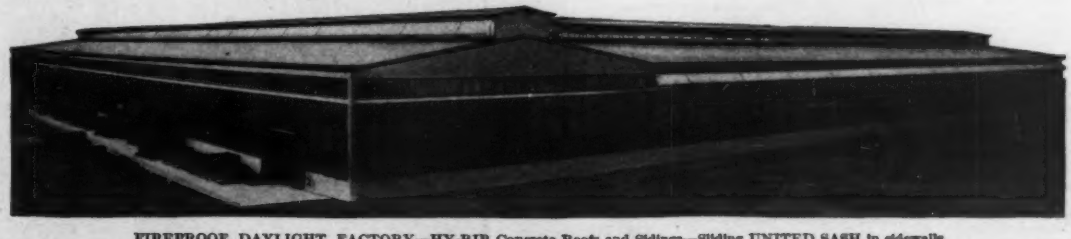

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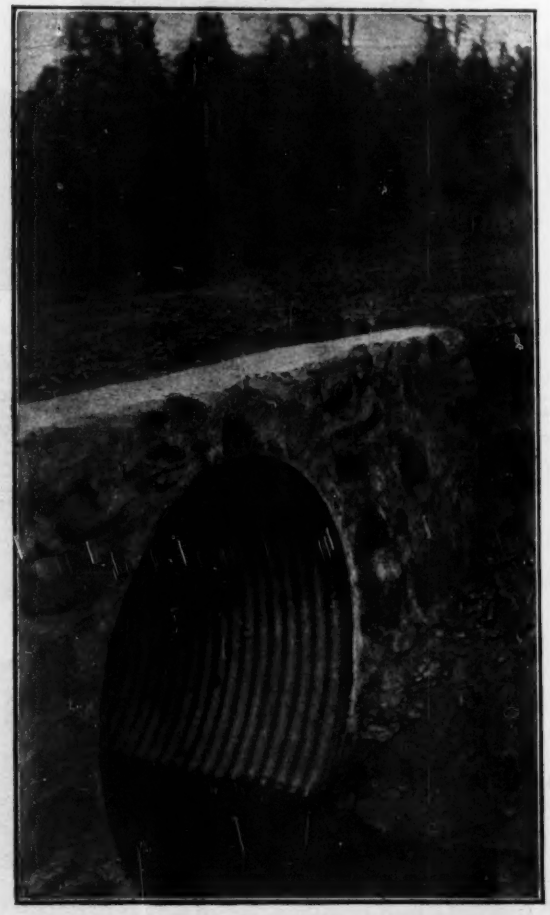

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North Dakota, Wahpeton
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Ohio, Elyria
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Ohio, Middletown
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Ohio Corrugated Culvert Co.
Oklahoma, Shawnee
Oklahoma Corrugated Culvert Co.
Oregon, Portland
Coast Culvert & Flume Co.
Pennsylvania, Warren
Pennsylvania Metal Culvert Co.
South Dakota, Sioux Falls
Sioux Falls Culvert Co.
Tennessee, Nashville
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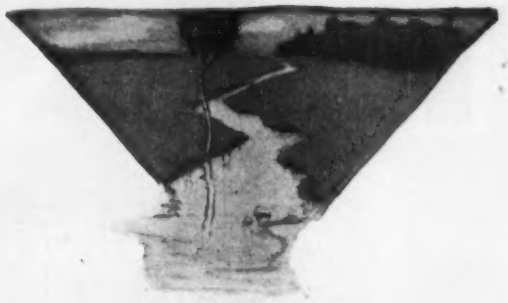

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NOW you can get meters that are exactly suited to the service for which you buy them. In cold climates there is a **Trident Meter** prepared for frost; where the nature of the water is apt to make repairs and replacements necessary, the **Trident Split Case Meter;** where the volume of water fluctuates between a tiny trickle and a rushing stream the **Trident Compound Meter,** etc.

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Getting the right type of meter means a great deal to the water works official—

To the satisfaction of his customers—

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A little study of the Trident Catalog will show you that there is a meter exactly suited to your conditions whatever those conditions may be.

And remember no matter what the type, the simplicity, ease of taking apart and assembling, the durability and high quality of materials used in a Trident Meter are always the same.

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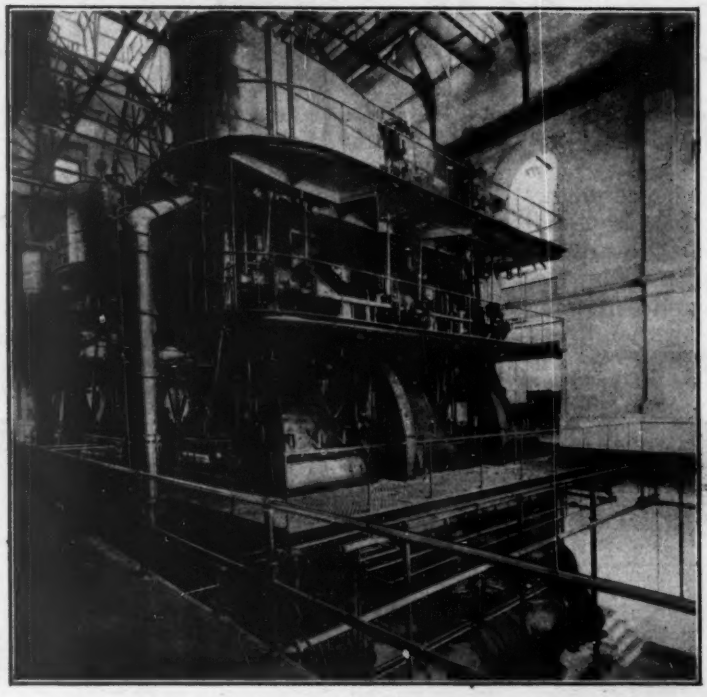
GAS ENGINES AND PUMPING ENGINES



Bethlehem Steel Vertical Triple Expansion and Horizontal Cross Compound Pumping Engines represent the highest development of operative economy and efficiency.

Recent installations at Chicago, Pittsburgh, Philadelphia, Baltimore, Detroit, Atlantic City, Bethlehem and Erie, Pa., are maintaining the highest efficiency records—the installation at Atlantic City exceeding its guarantee by 40,000,000 ft. lbs.

Bethlehem Steel Gas Engines are built in sizes from 800 to 5000 B.H.P. for operation on all kinds of gas. Over 90,000 B.H.P. in use and under construction.

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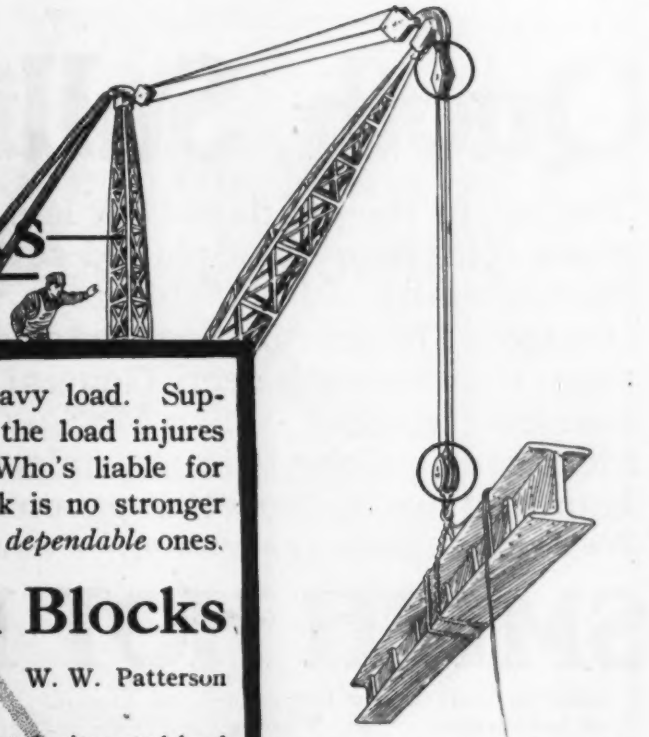
BETHLEHEM STEEL COMPANY

SOUTH BETHLEHEM, PA.

You pay for these lives if a block breaks—



SUPPOSE you're taking up a heavy load. Suppose something gives way and the load injures or kills some passing people. Who's liable for that—*who pays?* YOU. A derrick is no stronger than its blocks—so you *must* have *dependable* ones.

W. W. Patterson Blocks

are made with that one big idea in mind. W. W. Patterson Blocks *specialize* on *dependability.*

In an actual test a W. W. Patterson held *twice* its rated load without breaking. And then, after more weight was piled on it simply *stretched* apart—*did not break.*

It's how a W. W. Patterson Block is *made* that gives you this dependability. All hooks are of staybolt iron, flattened. The blocks themselves are entirely made by hand. All bushings are of Metaline or phosphor bronze—all materials must pass a rigid analysis. *That's* why these blocks are so *dependable.*

We send them to you on 60 days trial. The plan will be fully explained if you'll write for Block Book No. 2, sent for the asking without obligation. Write to us TODAY.

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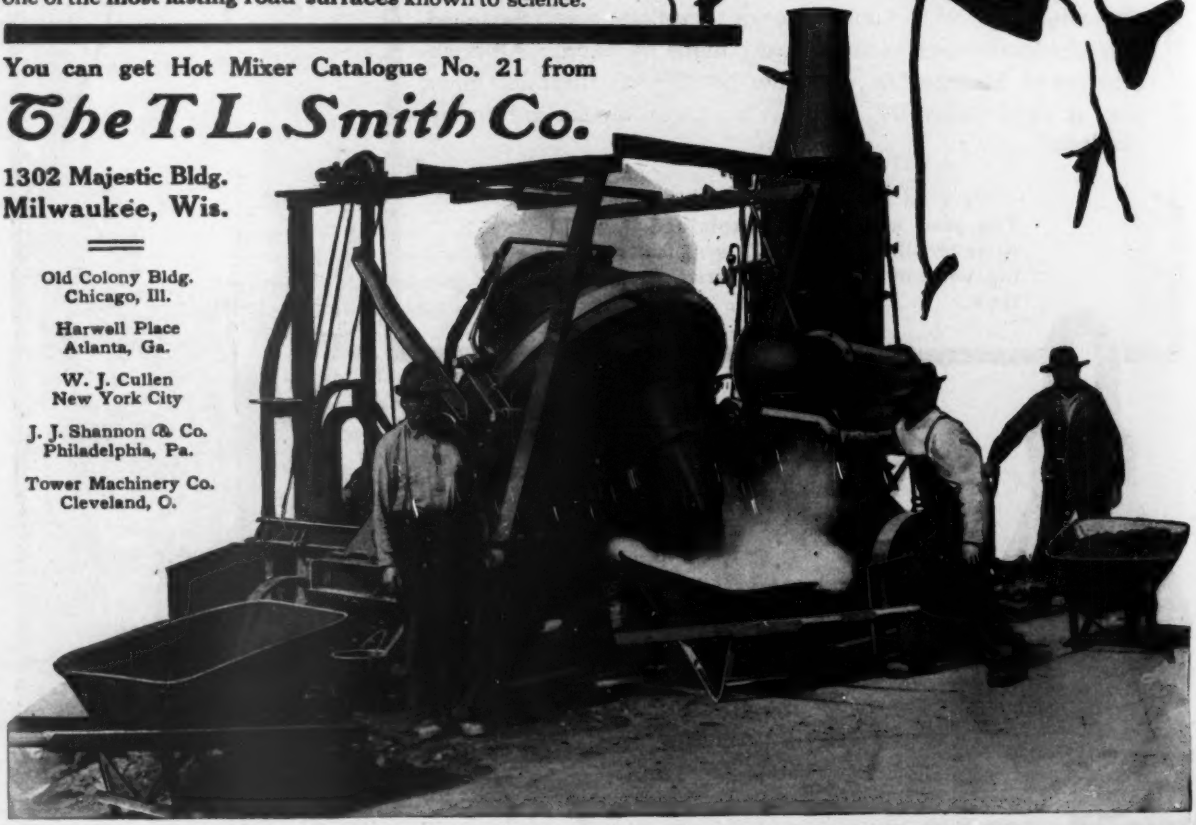
Quoth Sullivan:

"Yes, sir, in the old days they laid the stone cold, then they poured the asphalt over it; much of the bitumen was wasted. The penetration was seldom more than an inch deep. Generally it was less than that. Then, Mr. Six-Cylinder comes along, going 30 miles per hour, and rips up the whole pavement. **We don't do it that way any more; now we use a**

SMITH HOT MIXER

It heats the stone to any temperature, 350 degrees, if the specifications say so. Then you run in the asphalt; and the whole mass is **uniformly coated** without wasting an ounce of bitumen. There's no **question** about the penetration. No automobile can rip **this** surfacing from the street. It's **concrete,** asphaltic concrete, one of the **most lasting road surfaces** known to science."



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The T. L. Smith Co.

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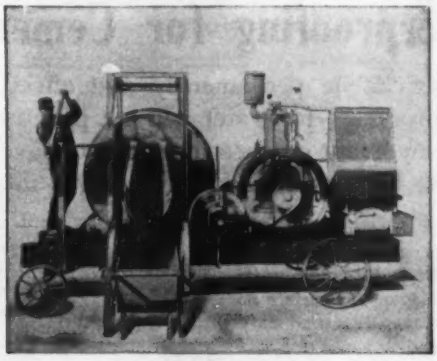
We sincerely hope not, but if it does then we trust that in 1913 we may help you to reduce your experience account by cooperation with you. We appreciate the importance of the experience account, the account which does not appear on the ledgers, the account that errors are charged to, and the account that may shift the yearly balance from the profit to the loss side of the books. We have been through the school of experience in the concrete field. We have been contractors, engineers and manufacturers in connection with the modern building material. We know how easy it is to make mistakes. Our experience has cost us dearly, but if you get in touch with Ransome Service you receive the benefits of this experience gratis.



Ransome Service means the handling of a concrete problem from beginning to end. It does not consist of merely selling the machinery for a specified job. It means a study of all the conditions; the design of the most economical concrete plant under the conditions; the equipping of this plant with every possible piece of machinery necessary, from "sand pile to forms." It goes further than this. After the plant is running it is visited by Ransome engineers who see to it that each machine is being operated at full earning capacity if possible. If anything does not go right it is remedied. Our whole aim is to see that the users of Ransome Machinery as far as possible have a plant in which the progress of the materials and concrete is like one steady stream.

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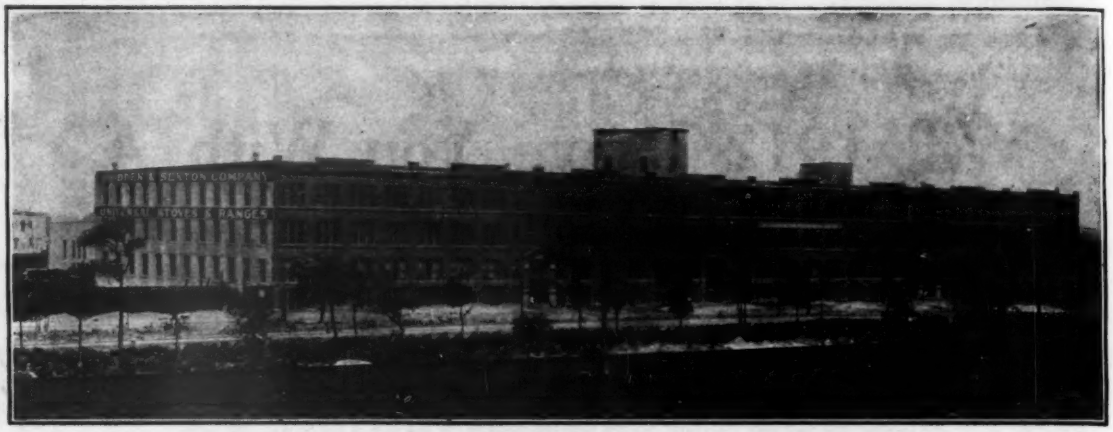

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A Reliable Waterproofing for Cement and Concrete

Concrete and cement mortar can be permanently and effectively waterproofed with a treatment of **Ceresit** Waterproofing—for water will not penetrate where **Ceresit** is. Many years of practical tests on important engineering projects have proven the water repellant properties of **Ceresit**, so that we can guarantee absolute satisfaction where it is used under our direction.

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Engineer of Construction.

Ceresit protects concrete against disintegration from frosts. **Ceresit** has been used with success on many important concrete engineering projects. Tunnels, dams, reservoirs, foundations, swimming pools, tanks, water towers, boiler pits, building walls, viaducts, aqueducts.

Write for Free Book "A" and try Ceresit waterproofing on your next job. Ceresit is used in all civilized countries. Ceresit is catalogued in Sweet's Index.

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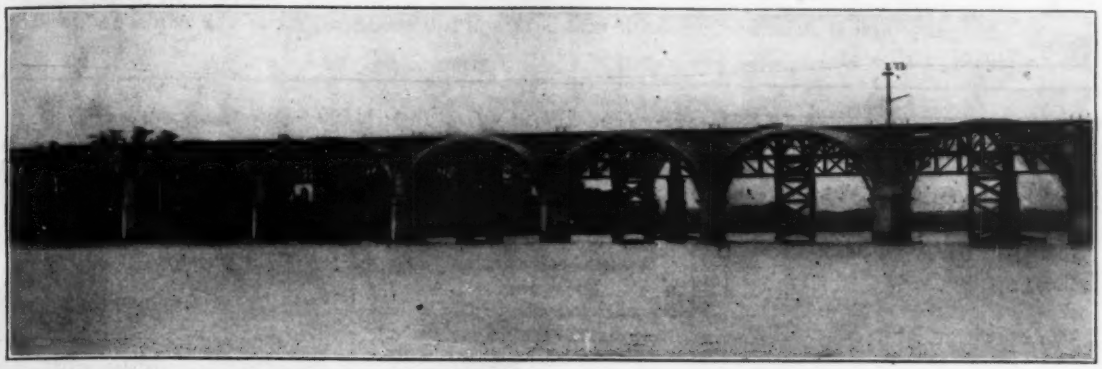

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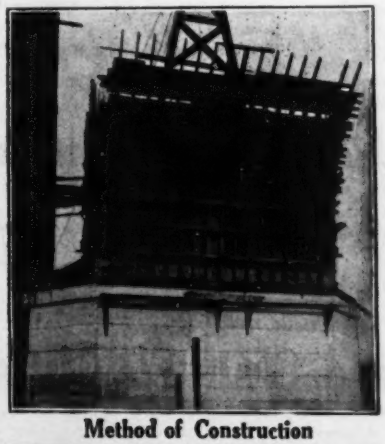
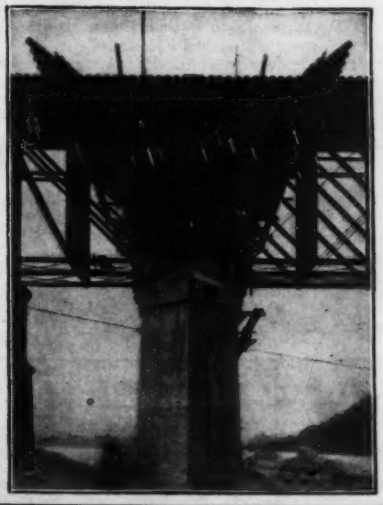


Method of Construction



DRAGON PORTLAND is being used exclusively on this large, 14-arch concrete railroad bridge now being built over the Delaware River, near where Washington made his famous crossing, from Yardley, Pa., to Wilburtha, N. J., for the Philadelphia and Reading Railroad.

The total length of the bridge is about 1450 feet.

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82 pages have been added in the new edition. The chapters on "Stresses in Framed Structures," "Stresses in Bridge Trusses" and "Specifications for Steel Frame Buildings," have been revised and re-written. The chief addition is in Appendix III, which contains 78 pages, with 30 tables and 24 cuts on "Structural Drawings, Estimates and Designs."

This book covers the calculation of stresses in and the principles of the design of steel frame structures. While steel mill buildings receive the main attention, the discussion and data apply to all forms of steel construction.

In the chapters on design, the materials used and the mtehods of construction are discussed, together with estimates of weight and cost.

The book contains details of floors, roofs, windows, ventilators, trusses, columns, and also rules and details for structural drafting, estimates and design.

Specifications are given for steel frame buildings, making the book a complete treatise on steel construction.

Issued in May, 1912.

Design of Mine Structures

Cloth, 6½x9, 460 *pp.*, 265 *illus.*, 7 *folding plates.* $4.00 (17*s*) *net, postpaid.*

This book covers the design of head frames, coal tipples, coal washers, coal breakers, concentrators, mine buildings, bins, retaining walls, trestles, and other mine structures made of steel, timber and reinforced concrete. The operations of hoisting and other preliminary processes are described in detail, but the design of the hoists and other machinery is not covered.

Second Edition—Total Issue 3,000—*Oct.,* 1911.

Walls, Bins and Grain Elevators

Cloth, 6½x9, 556 *pp.*, 304 *illus.* $4.00 (17*s*) *net, postpaid.*

A systematic analysis of the stresses due to granular materials, together with a discussion of the principles of the design and details of the structures to contain the granular materials. The design of retaining walls is taken up first, after which the design of bins and grain elevators is discussed in detail.

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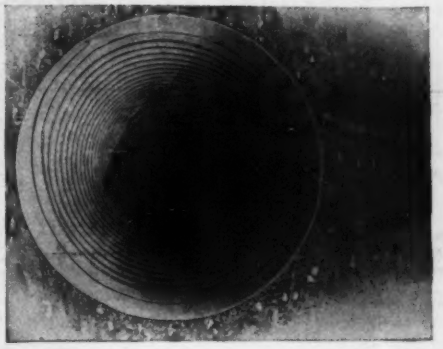

A Raymond spirally reinforced shell of sheet steel, in place, ready to be filled with concrete. The shells for Raymond Concrete Piles *remain in the ground.* They absolutely prevent distortion, or changes in cross section, of the piles. How well they perform this function even under the most adverse conditions is shown in the accompanying illustration.

Raymond Concrete Piles disclosed by excavation at the plant of the Youngstown Sheet & Tube Company, Youngstown, Ohio, where we are driving approximately 300,000 ft. of concrete piling. The piles are being driven through a slag fill into the underlying natural strata. Note the perfect condition of the piles laid bare by the excavation.

CONCRETE Raymond PILES

are made by driving a tapering sheet steel shell to refusal by means of a collapsible steel mandrel, withdrawing the mandrel and thereupon filling the shell with concrete. The shell remains in the ground. Prior to filling, it is carefully inspected. Under ordinary conditions, we employ shells made of plain sheet steel. Where back-pressure is unusually severe, however, we use spirally reinforced shells that are made by grooving plain sheet steel shells over a spiral of heavy wire that fits snugly into the corrugations on the shells. The reinforcement increases the compressive strength of the pile, and the resistance of the shell to back-pressure. The shell that remains in the ground is responsible for the fact that throughout our experience of eleven years, during which we have driven over three and a half million feet of concrete piling, no Raymond Concrete Pile foundation has ever failed to support satisfactorily the weight of its super-imposed load. The necessity for allowing the shell to remain in the ground is indicated by the fact that failures in made-in-place concrete piling have occurred only in those types in which the shell is withdrawn. As Raymond Concrete Piles are the one type of made-in-place concrete piling in which a shell that remains in the ground is used for every pile, they are only made-in-place concrete piles that can be depended upon to support their super-imposed loads satisfactorily.

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The wonderful Bush Terminal in Brooklyn, N. Y., illustrated below, includes 181 buildings, comprising tremendous warehouses, enormous pier sheds for docking ocean steamers, huge factory buildings, a large modern power house and an enormous freight structure.

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1. Low first cost.
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4. They are fire retardent and take the base rate of insurance.
5. The net unit cost, that is, the cost per foot per year of service, is lower than that of any other type.

Although some of the buildings are fifteen years old, the roofing contractor states that the expense for maintenance of this entire roof area has been less than $10.00. He estimates that if metal or ready roofings had been used, it would have been impossible to keep the buildings free from leaks and that the painting bill alone up to date would probably have amounted to at least $50,000.00.

We wrote to the Bush Terminal Company, asking what they thought about Barrett Specification Roofs. The Vice-President replied:

> "We use this kind of roofing because our experience has shown it to be the best and cheapest. Our analysis of first cost of application and cost of maintenance entitles us to speak with some measure of authority."

We shall be pleased to mail architects, engineers or owners of buildings copy of the Barrett Specifications with diagrams from which blue prints can be made. Address our nearest office.

Barrett Manufacturing Company

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Special Note

We advise incorporating into plans the full wording of The Barrett Specification, in order to avoid any misunderstanding.

If any abbreviated form is desired however the following is suggested.

ROOFING—Shall be a Barrett Specification Roof laid as directed in printed Specification, revised August 15, 1911, using the materials specified and subject to the inspection requirements.

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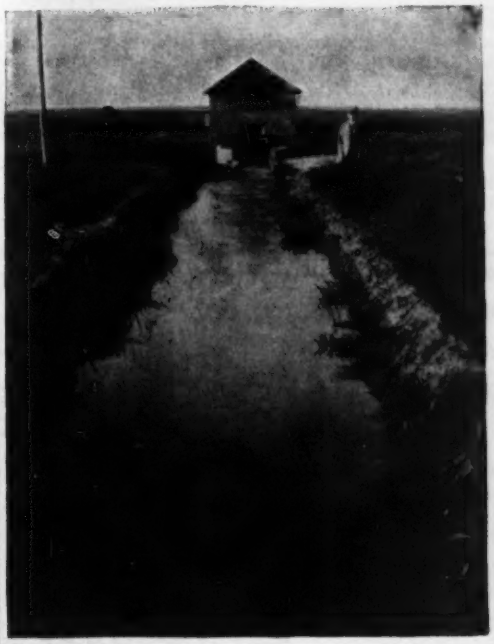

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DEVELOPING Centrifugal Pump design to a science and building regularly over 50 styles of centrifugals enables us to produce a centrifugal of greatest economy for nearly any pumping condition.

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This pump is made in sizes to operate in drill-holes 12 to 30 inches in diameter, produces best results on heads to 150 feet and delivers from 700 to 3,000 gallons of water per minute.

It is operated with vertical type motor, as illustrated, with vertical pulley directly attached to shaft, or with tight and loose horizontal pulley connected with the shaft by bevel gears.

Many of the most successful small irrigation pumping plants in America are now equipped with this type of "American" Turbine Centrifugal.

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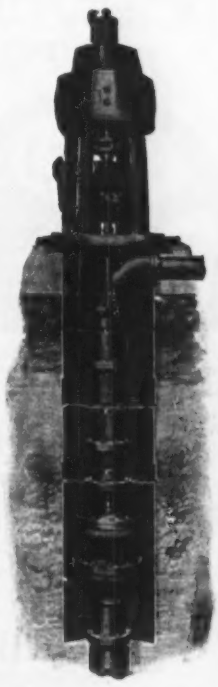

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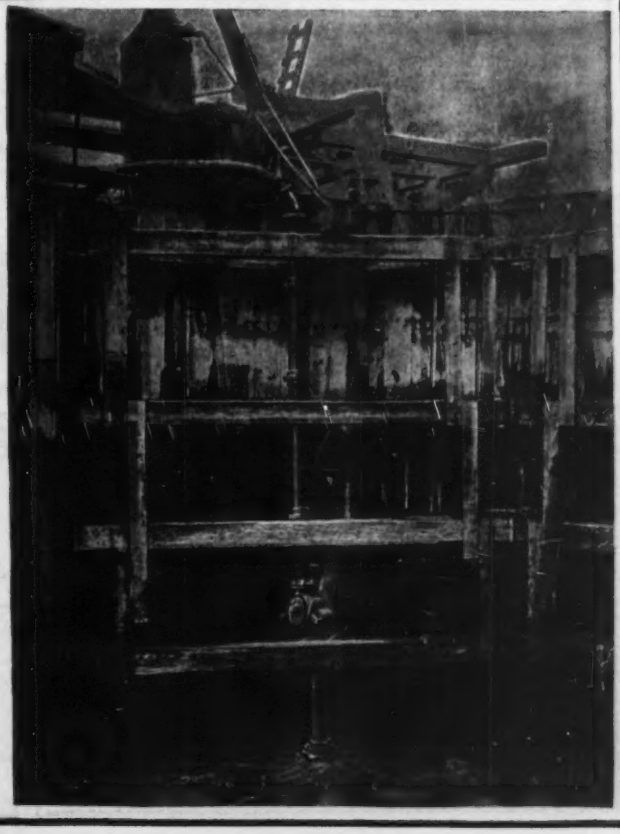

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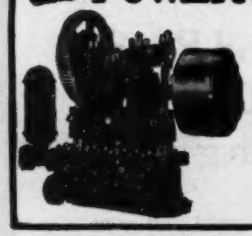

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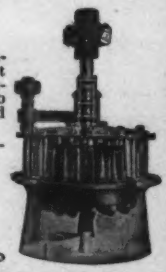

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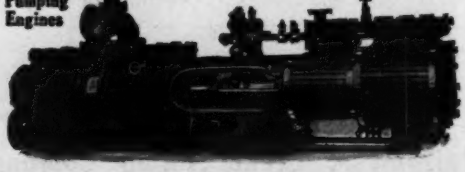

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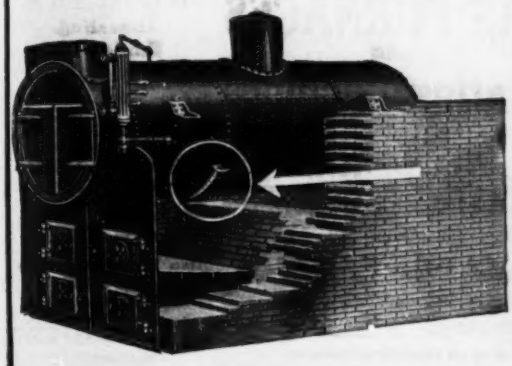

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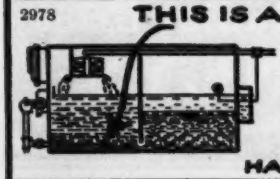

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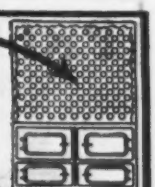

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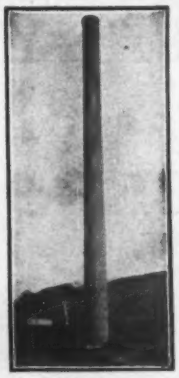

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CONIFORM AND CYLINDRICAL TYPES
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AUTOMATIC SPRINKLER
operating WHEN and WHERE the fire STARTS is worth more than a whole fire department
A FEW MINUTES LATER
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EACH 20° F. in the temperature of the flue gases represents 1 per cent. waste of fuel. A Green's Economizer will reduce the temperature of the flue gases from 500° F. or 600° F. to 250° F. or 300° F., saving 10 to 15% of the fuel bill. Because of the lower temperature of its contents, the economizer is more active in recovering heat than additional boiler surface would be. The Economizer also increases the steaming capacity and provides heat storage.

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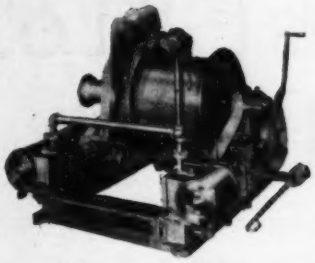

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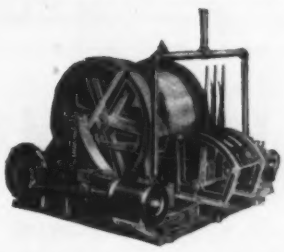

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FOR MACHINERY BRAKES

is made of pure, long-fibred Asbestos with strong brass wires interwoven in every strand. Asbestos can not char, burn or be injured by oil, water, etc.

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Made in lengths, widths and thicknesses to fit any size brake.

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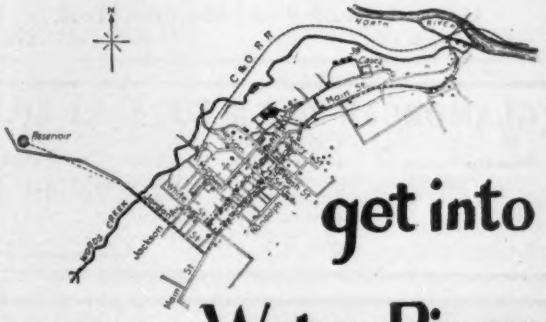

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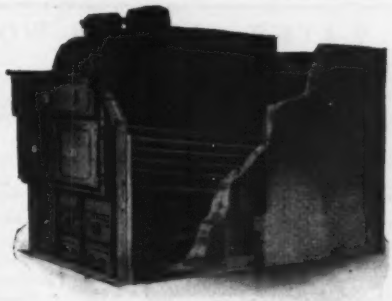

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The superheat cannot rise unduly, or fluctuate severely and cause rupture of cast parts or other mechanical troubles.

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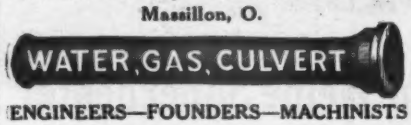

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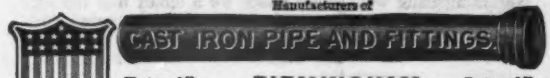

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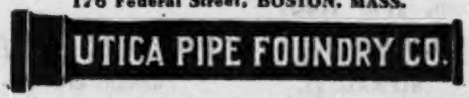

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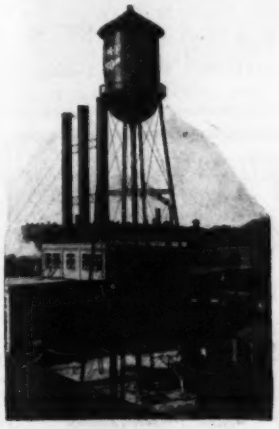

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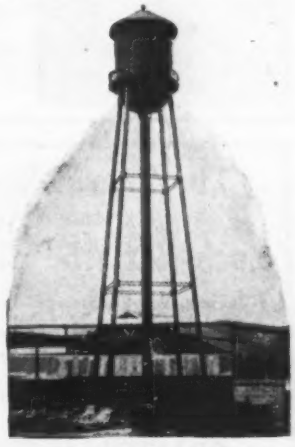

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Tankage for all purposes, large or small. Oil Refinery Equipment. Stand Pipes, Water Towers. Guyed and Self-Supporting Smoke Stacks. Penstocks. Flumes. Riveted Steel Pipe. Blast Furnaces. Hot Metal Ladles. Boilers. "Seigh" Patent Annealing Boxes. "Leman" Counter Current Condensers. Creosoting Cylinders. "Gem" Fuel Oil Burners. "Washington" Automatic Oil and Gas Separators. Portable Receiving Tanks

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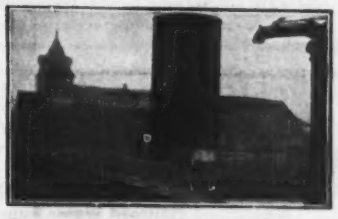

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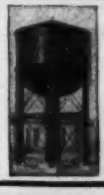

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For Any Service

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General Sales Office: 182 Broadway, New York
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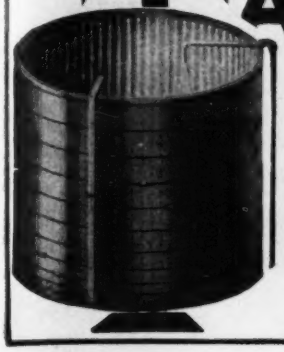

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MADE from famous California Redwood and selected Douglas Fir. Machine Banded Pipe 2 in. to 24 in. diameter. Continuous Stave Pipe 12 in. to 12 ft. diameter. Send for copy Mining Catalog No. 7, Tank Booklet, or Pipe Booklet. All full of valuable information.

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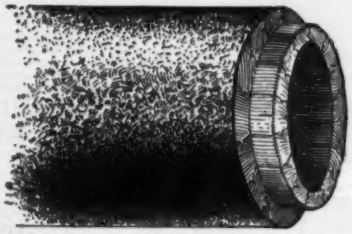

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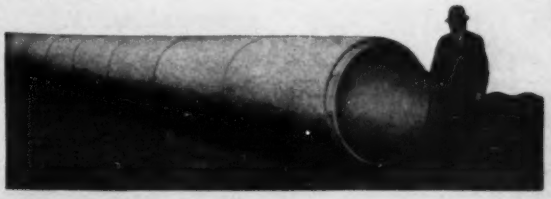

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Every little detail of construction and resisting qualities of Standard Wood Pipe comply with the exacting requirements of engineers. That's why Standard Wood Pipe is specified for all the important projects. The details are interesting.

Just ask for Catalog.

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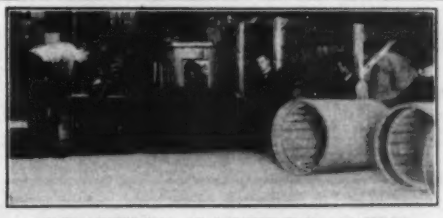

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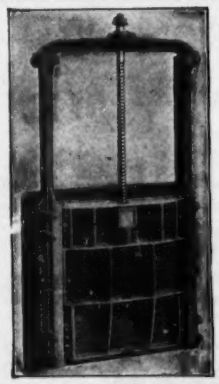

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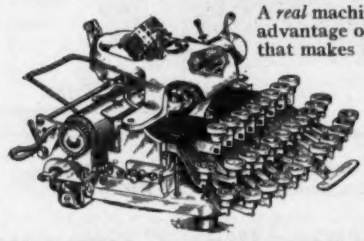

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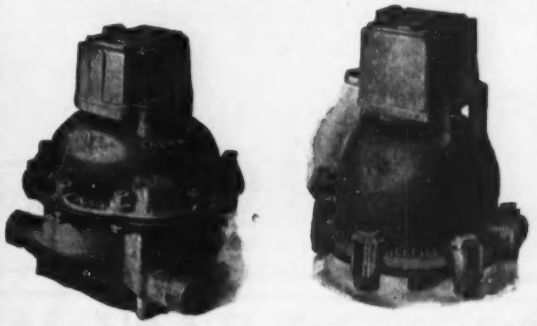

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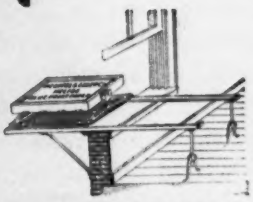

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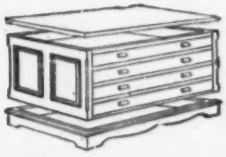

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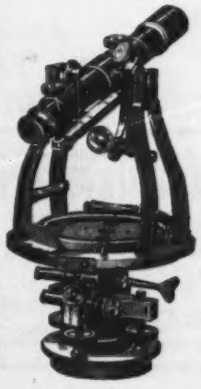

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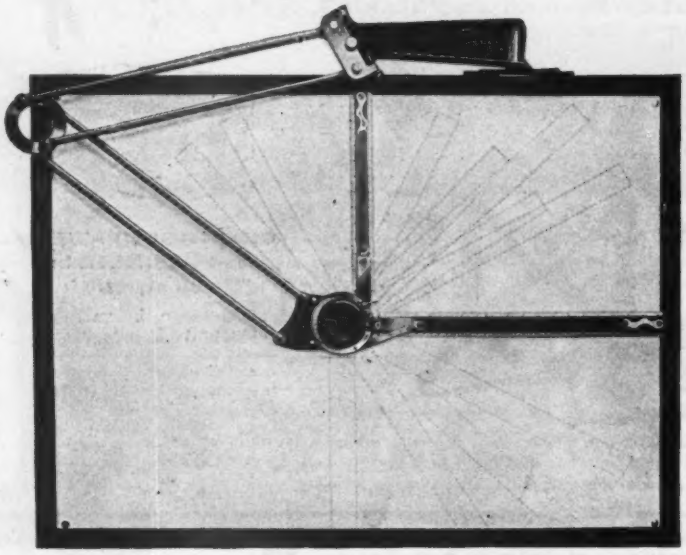

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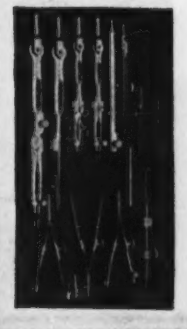

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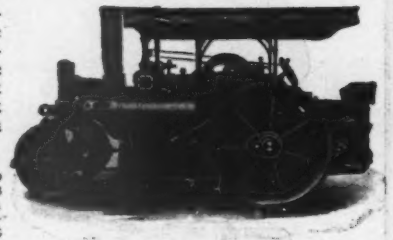

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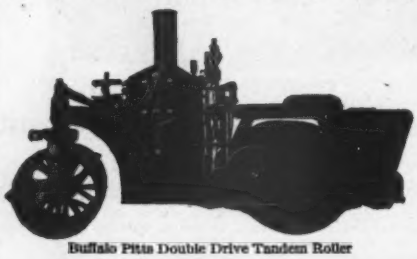

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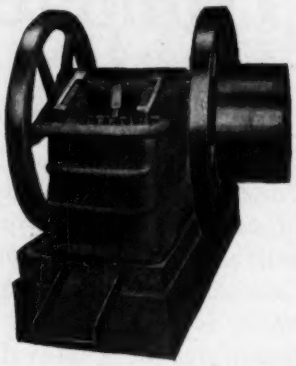

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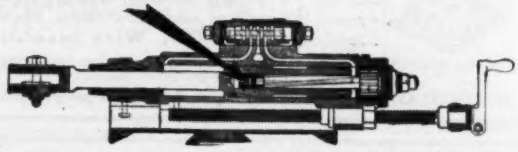

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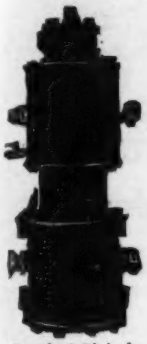

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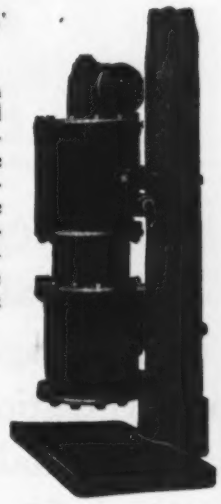

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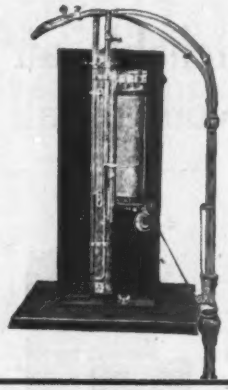

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8vo, vii+75 pages, figures throughout the Text, and two folding plates. Cloth, $1.50 net.

These notes have been used by the author to give his civil engineering students the theoretical and practical information necessary to enable them to make a design and general detailed drawing for a through plate-girder railway bridge.

FOURTH EDITION, REVISED

MASON'S

Examination of Water (Chemical and Bacteriological)

12mo, v+167 pages. Illustrated. Cloth, $1.25

This book gives the merest suggestions for determination of the mineral matters present in a water, while the items properly lying within the scope of a sanitary examination are dealt with more at length.

SECOND EDITION, REVISED AND ENLARGED.

TURNEAURE & RUSSELL'S

Public Water-Supplies

Requirements, Resources, and the Construction of Works

8vo, xv+808 pages, 229 figures. Cloth $5.00.

Owing to the noteworthy development in the design and construction of works for public water-supplies, the authors, in revising this work, have endeavored to bring it into accordance with the best modern practice. The literature of each chapter has also been extended and brought up to date.

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WILLIAMS & HAZEN'S

Hydraulic Tables

8vo, vi+104 pages. Cloth, $1.50.

The Elements of Gagings and the Friction of Water Flowing in Pipes, Aqueducts, Sewers, etc., as Determined by the Hazen and Williams Formula; and the Flow of Water Over Sharp-edged and Irregular Weirs, and the Quantity Discharged, as Determined by Bazin's Formula and Experimental Investigations upon Large Models.

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FOLWELL'S

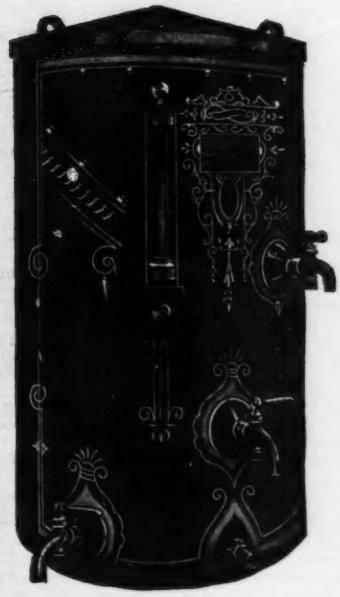
Water-Supply Engineering

8vo, xiv+570 pages, illustrated with 95 figures and 19 full-page plates. Cloth $4.00.

The Designing. Construction, and Maintenance of Water-Supply Systems, both City and Irrigation.

If The Cross Oil Filter Satisfies These Firms,

Why Not You?



We have sold the Standard Oil Company 228 Cross Filters for use in their own pumping stations.

The U. S. Steel Corporation have 350 Filters of our make in use in their various plants.

Certainly there can be no doubt that such concerns as these would use the very best filters they could buy—a fact which speaks pretty well for Burt Filters.

For filtering engine and common machinery oils it has proved its superiority over all others. Low cost of maintenance (only a few cents a year, for waste) is one important feature.

We have received our *fifth* order for Cross Oil Filters for use at the Panama Canal, where they are also using our Burt and Standard Exhaust Heads.

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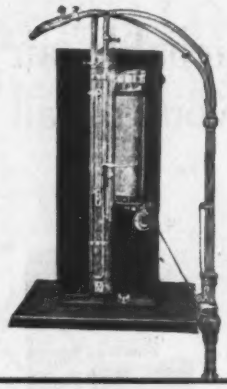
The Burt Mfg. Co., 700 Main St., Akron, O., U. S. A.

Largest Manufacturers of Oil Filters in the World.
We also manufacture a complete line of Exhaust Heads and Ventilators.



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The City of Washington, D. C., has found and stopped

30,000,000 gallons daily

in underground leakage by the use of our Pitometers.

New York City and Chicago also are using them with good results.

We make WATER WASTE SURVEYS with our own experienced engineers.

The Pitometer Company

220 Broadway NEW YORK

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Deflections and Statically Indeterminate Stresses

Small 4to, xiii+258 pages, profusely illustrated, with figures in the text, and full page plates. Cloth, $3.50 net.

A sufficient number of examples have been given in this book to show how the solution of problems in deflections and statically indeterminate structures may be made on

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8vo, vi+104 pages. Cloth, $1.50.

The Elements of Gagings and the Friction of Water Flowing in Pipes, Aqueducts, Sewers, etc., as Determined by the Hazen and Williams Formula; and the Flow of Water Over Sharp-edged and Irregular Weirs, and the Quantity Discharged, as Determined by Bazin's Formula and Experimental Investigations upon Large Models.

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FOLWELL'S

Water-Supply Engineering

8vo, xiv+570 pages, illustrated with 95 figures and 19 full-page plates. Cloth $4.00.

The Designing, Construction, and Maintenance of Water-Supply Systems, both City and Irrigation.

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Electric Time Recorders or Operation Recorders

as illustrated, herewith, are cataloged in new Bulletin No. 138 just off the press. Bulletin No. 139 on Bristol's Mechanical Time Recorders also just printed.

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THE BRISTOL CO., Waterbury, Conn.

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We have received our *fifth* order for Cross Oil Filters for use at the Panama Canal, where they are also using our Burt and Standard Exhaust Heads.

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Largest Manufacturers of Oil Filters in the World.
We also manufacture a complete line of Exhaust Heads and Ventilators.

CONTRACTS TO BE LET

Proposals for Government, Municipal and Other Work

Improving Canals

STATE OF NEW YORK
OFFICE OF THE SUPERINTENDENT OF PUBLIC WORKS.
Albany, December 2nd, 1912.

NOTICE TO CONTRACTORS:—

Sealed proposals will be received by the undersigned at his office in the Capitol in Albany, N. Y., until twelve o'clock noon of Tuesday, December 31st, 1912, at which place and hour they will be publicly opened and read, for improving the Cayuga and Seneca canal pursuant to the provisions of Chapter 391 of the Laws of 1909, and Chapter 147 of the Laws of 1903, and of the amendments thereto, and for improving the New York State canals pursuant to the provisions of Chapter 147 of the Laws of 1903, and of the amendments thereto, as follows:

1

CONTRACT C.

Cayuga and Seneca Canal, Section 1.

For constructing locks, dams, etc., at Seneca Falls.

Length 1.1 miles. Sheets 1 to 34 inclusive.

2

CONTRACT E

Cayuga and Seneca Canal, Section 1.

For constructing a lock, dam, etc., at Waterloo.

Length 0.21 mile. Sheets 1 to 24 inclusive.

3

CONTRACT NO. 92

Erie Canal—Sections 1 to 4

Champlain Canal—Sections 1 to 2.

Power plants, electrical equipment and machinery for operating and lighting locks and guard gate as follows:

Erie Canal.....Locks 2 to 19 inclusive

Champlain Canal..Locks 1 to 8 inclusive, and Guard Gate, Station 293 + 70, Erie Canal.

Sheets 1 to 107 inclusive.

4

CONTRACT NO. 94

Erie Canal—Sections 8 to 11.

Power plants, electrical equipment and machinery for operating and lighting locks as follows:

Erie Canal, Locks 26, 27, 28-A, 28-B, 29, 30, 32, 33, 34-35;

Guard Lock, Station 2413 + 42 and Guard Lock

Station 2468 + 48, near the Genesee river.

Sheets 1 to 45 inclusive.

Plans may be seen and detailed specifications, engineer's estimate of quantities, proposal blanks, form of contract and bonds required and other information for proposers may be had at the office of the Superintendent of Public Works at Albany, N. Y., at the office of the Assistant Superintendent of Public Works for the Middle Division at Syracuse, N. Y.; at the office of the Assistant Superintendent of Public Works for the Western Division at Rochester, N. Y.; and at the canal office, Spaulding's Exchange, Buffalo, N. Y.

Copies of detailed plans or drawings may be obtained from the State Engineer and Surveyor at Albany, N. Y., upon payment to him of the cost of producing them.

Monthly estimates will be paid of ninety per centum (90 per cent.) of the work done at the contract price. Every proposal for said work must be accompanied by a money deposit in the form of a draft or certified check upon some good banking institution in the city of Albany or New York, issued by a national or state bank in good credit within the State and payable at sight to the Superintendent of Public Works for five per centum (5 per cent.) of the amount of the proposal.

The person whose proposal shall be accepted will be required to execute a contract and furnish bonds within ten days from the date of notice of award delivered to him or them in person or mailed to the address given in the proposal.

Upon execution of the contract and approval of bonds, the certified check or draft will be returned to the proposer unless the same shall have been presented for collection prior to such time, in which case the amount of the deposit will be refunded by the Superintendent of Public Works.

The deposits of bidders other than the one to whom the award of contract shall be made will be returned immediately after the award has been made.

The amount of bond required for faithful performance will be ten per centum (10 per cent.) of the amount of the estimated cost of the work according to the contract price, and an additional bond, known as the labor bond, in the sum of ten per centum (10 per cent.) of the amount of the estimated cost of the work according to the contract price, will be required as security that the contractor will pay in full at least once in each month all laborers employed by him upon the work specified to be done in the contract.

In the event that more than one surety company is offered as surety on said bonds, co-insurance only will be accepted.

Each proposal must be addressed to the Superintendent of Public Works, Albany, N. Y., and must be endorsed on the envelope with the name of the construction for which the proposal is made.

Award, if made, will be made to the person or persons whose proposal shall be lowest in cost to the State for doing the work, and which shall comply with all provisions required to render it formal. Before any award shall be made the lowest bidder will be required to satisfy the Superintendent of Public Works of his ability to provide suitable equipment and materials for the proper performance of the work.

The right is reserved to reject all proposals and readvertise and award the contract in the regular manner if, in the judgment of the undersigned, the interests of the State will be enhanced thereby.

DUNCAN W. PECK,
Superintendent of Public Works.

Water Works Improvements

Rock Hill, S. C.

Sealed proposals will be received by the Public Works Commission of the City of Rock Hill, S. C., until 3 P. M., January 21st, 1913, for building a Water Works Plant.

The work will consist of Auxiliary and Main Pump Station, Electric Pumps, 1,000,000 gallon filter plant and reservoir, and about 5 miles of 12 inch pipe line to the Catawba River.

Plans and specifications will be on file at the office of the Superintendent at Rock Hill, S. C., and at the office of the Engineer at Charlotte, N. C. and specifications, bidding sheet, etc., will be mailed on application to the Engineer.

A complete set of plans will be mailed on payment of $5.00 to cover cost.

No bid will be considered unless accompanied by a certified check for not less than 5 per cent. of the amount of bid (said check to be in no case less than $250.00) as an evidence of good faith.

The right is reserved to reject any or all bids.

J. B. JOHNSON, Chm.

Engineer:
GILBERT C. WHITE,
Charlotte, N. C.

Chimney

Tarentum, Pa.

Sealed proposals, endorsed "Proposals for Chimney at Electric Light Plant," will be received by the Electric Light Committee of the Borough Council of Tarentum, Pa., until 8 P. M., January 6th, 1913, at the Borough Hall. All proposals are to be addressed to Mr. W. A. Gibson, Borough Secretary.

Proposals will be received for a Chimney 100 feet high and 60 inches inside diameter. To be constructed of either reinforced concrete, brick, selfsupporting steel, or radial block. Each proposal must inclose a detailed drawing showing all features of the Chimney bid upon.

Proposals are to include the Chimney completely erected on a foundation furnished by the Borough and the flues to two (2) existing batteries of boilers are to be connected to the Chimney by the Contractor.

The Borough Council reserves the right to reject any or all proposals.

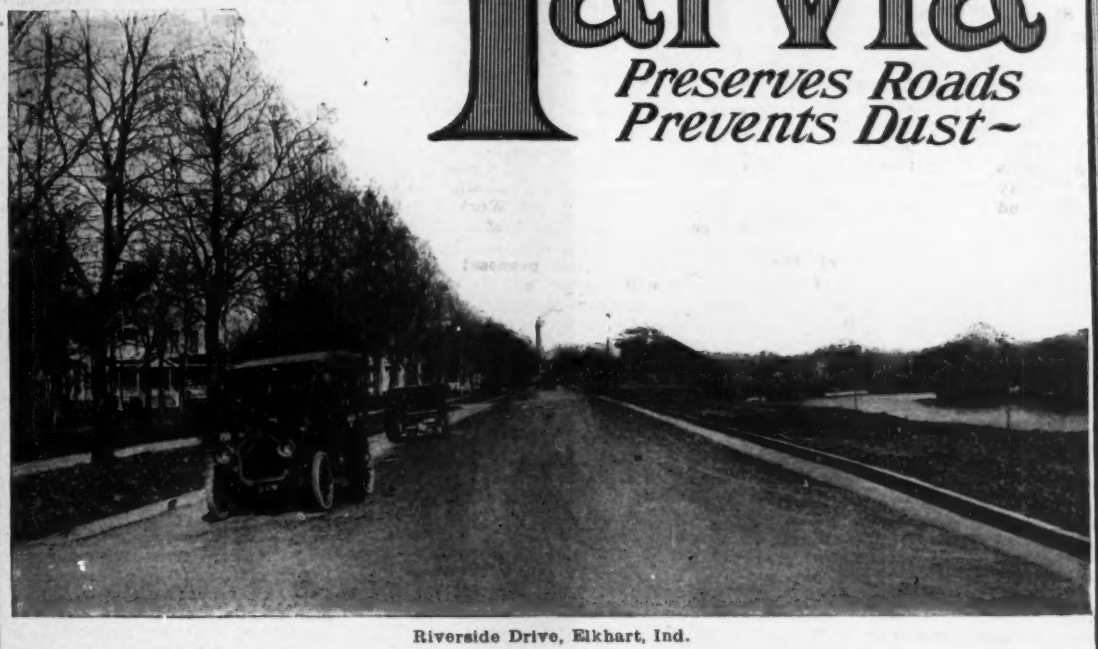
W. A. GIBSON,
Borough Secretary.

LEO HUDSON,
Engineer,
McKeesport, Pa.

U. S. ENGINEER OFFICE, Norfolk, Va., Dec. 20, 1912.—Sealed proposals for dredging in James River, Va., will be received at this office until 12 o'clock, noon, Jan. 20, 1913, and then publicly opened. Information on application at this office or at U. S. Engineer Office, 28 N. 9th St., Richmond, Va. E. EVELETH WINSLOW, Lt. Col. Engrs.

Tarvia

Preserves Roads
Prevents Dust~



Riverside Drive, Elkhart, Ind.

Elkhart's Experience with Tarvia

WHEN ordinary macadam is laid on a boulevard where there is considerable automobile traffic, the macadam will last about a year; sometimes it will go to pieces in less time than that. At any rate, its life under such conditions is never long, because plain macadam lacks sufficient cohesiveness to enable it to resist the thrust of automobile driving wheels.

Tarvia is a dense, tough, waterproof, viscid tar product which can be incorporated into the macadam during construction so as to form a matrix for the stone. In this construction the stone does not ravel or loosen; it is held to its work despite automobile traffic. The road remains smooth, firm and dustless for years.

A typical boulevard built in this fashion is Riverside Drive, Elkhart, Ind., which was constructed in 1909 and 1910, using 2½ gallons of Tarvia X per square yard. The road complete cost $1.06 per square yard and proved a great success.

Mr. Amandus M. Smith, City Engineer of Elkhart, wrote on October 1, 1912:

"To-day the road is as good as when constructed. We feel proud of this boulevard, as it proved most satisfactory, and have received the finest compliments on this splendid drive."

Our experts are ready to show any city or town how to get the same results.

There are three kinds of Tarvia—Tarvia X for road and pavement construction, Tarvia A for surface work and Tarvia B for dust suppression and road preservation. The first two are very dense and viscid and require heat for application. Tarvia B is applied cold. Booklets free on request.

Barrett Manufacturing Company

New York Chicago Philadelphia Boston St. Louis Cleveland Pittsburgh
Cincinnati Kansas City Minneapolis Seattle Corey, Ala.

The Paterson Mfg. Co., Ltd.:—Montreal, Toronto, Winnipeg, Vancouver, St. John, N.B., Halifax, N.S.

Jerome Park Filters

DEPARTMENT OF WATER SUPPLY, GAS AND ELECTRICITY, ROOM 1903, 13 TO 21 PARK ROW, BOROUGH OF MANHATTAN, CITY OF NEW YORK.

Sealed bids or estimates will be received by the Commissioner of Water Supply, Gas and Electricity at the above office until 2 o'clock p. m. on

WEDNESDAY, JANUARY 8, 1913,

FOR THE CONSTRUCTION OF THE JEROME PARK FILTERS, BOROUGHS OF MANHATTAN AND THE BRONX.

The work consists of the construction and equipment of 80 mechanical filters consisting of concrete tanks having a net filtering area of about 2.7 acres; covered concrete settling basins having an area of about 12 acres, and a capacity of about 88 million gallons; a covered concrete filtered water reservoir having an area of about 55 acres, and a capacity of about 350 million gallons; 5 concrete gate chambers, a concrete house for the preparation of chemicals, and all piping, valves and filter equipment.

The total excavation amounts to about 800,000 cubic yards and the total concrete masonry about 350,000 cubic yards. A considerable portion of the work is in the item for filter equipment, which consists of piping, valves, strainer system, operating tables, apparatus for handling and applying chemicals, etc.

The time allowed for doing and completing the work is thirty-six (36) calendar months.

The security required is One Million Dollars ($1,000,000).

In addition thereto, a supplementary bond in the sum of One Hundred and Fifty Thousand Dollars ($150,000) shall be furnished by the contractor prior to the acceptance of the work and continuing for six years thereafter to protect the City against any claims for infringements of patents, due to any work done or materials or processes used or installed by the contractor.

The bidder will state the price per unit for each item of work contained in the specifications or schedule by which the bids will be tested. The bids will be compared and the award will be made to the lowest bidder.

Any repairs needed due to defects in materials or workmanship, shall be made by the contractor during a period of one year from the completion of the work.

The Commissioner reserves the right to reject all bids or estimates if he deems it to be to the interest of the City so to do.

A deposit of Twenty-five Dollars ($25) will be required from all applicants for each copy of the plans and specifications. This deposit will be returned if said copies of the plans and specifications are delivered to the Department within five (5) days after the opening of the bids, provided they are in good condition.

Bidders are requested to make their bids or estimates upon the blank form prepared by the Department, a copy of which, with the proper envelope in which to enclose the bid, together with a copy of the contract, including the specifications, in the form approved by the Corporation Counsel, can be obtained upon application therefor at the office of the Department, Room 1903, 13 to 21 Park Row, Borough of Manhattan.

Dated November 25, 1912.

HENRY S. THOMPSON, Commissioner.

See General Instructions to Bidders on the last page, last column, of the "City Record," published at 96 Reade St., New York City.

Drainage Channel Excavation

Batavia, N. Y.

NOTICE TO CONTRACTORS

Bids will be received at Hotel Richmond, Batavia, N. Y., on January 3, 1913, at 2 p. m., by undersigned Commissioners, for approximately one million cubic yards drainage channel excavations in the Tonawanda-Oak Orchard swamps, Counties of Genesee and Orleans, N. Y. Separate sealed bids will be received for the work, (A) as an entirety, (B) for the main channel, (C) for submains, and (D) for lateral channels. Each bid must be accompanied either by cash or preferably by certified check, payable to order of Commissioners, of a responsible bank, in case of A for $5,000.00, B for $1,600.00, C for $1,000.00, and D for $2,400.00; which, in case of the successful bidder, shall be retained until the contract is executed and bond of Surety Company given, to be forfeited to Commission in case of failure to execute such contract and give such bond. The form of the contract and bond to be entered into, and all further particulars, may be obtained from M. W. Weir, the engineer at Elba, Genesee Co., N. Y., J. W. Holmes, Batavia, N. Y., or John J. Ryan, Medina, N. Y., where the proposed contract, specifications and plans may be seen. Copies of the plans, contract and specifications may be obtained from said engineer for the sum of $5.00.

The right is reserved by the Commission to reject any and all bids.

Dated, December 7th, 1912.

JOSEPH W. HOLMES,
JOHN CROWLEY,
MORTON A. BOWEN,
Commissioners.

OFFICE OF YOSEMITE NATIONAL PARK, CALIFORNIA, November 30, 1912.—Sealed proposals, in duplicate, will be received at this office until 2 o'clock p. m., February 1, 1913, for the construction of four reinforced concrete arch highway bridges as follows: Bridge No. 1, One arch, 105 foot span, 12½ foot rise, and 36 feet clear width. Bridge No. 2, One arch, 20 foot span, rise 3½ feet, width 17½ feet over all at crown. Bridge No. 3, Same dimensions as No. 2. Bridge No. 4, Two arches, 20 foot span each, rise 3½ feet, and width 17½ feet over all at crown. Bidders must bid on each bridge separately, but may give a lump bid on all four bridges, or on any two or any three of the bridges. The bridges are to be constructed on the floor of the Yosemite Valley, and it is suggested that prospective bidders personally inspect the various sites before submitting proposals. Each bid must be accompanied by certified check for $500 payable to the order of the Secretary of the Interior, which sum to be forfeited to the United States should the bidder fail to enter into contract with satisfactory surety to the full amount of his bid within 30 days from notice of award. The right is reserved to reject any and all bids and accept bids on any one, two, or three of the bridges, as may be deemed most advantageous to the Government. Plans, specifications, and blank forms of proposal may be obtained on application to the Acting Superintendent of the Yosemite National Park, Yosemite, California, and may be seen and examined in the U. S. Engineer Office, Room 405 Custom House, San Francisco, California, and the office of The Builder and Contractor, Los Angeles, California. WM. W. FORSYTH, Lt. Colonel of Cavalry, Acting Superintendent, Yosemite National Park. Approved, Lewis C. Laylin, Assistant Secretary of the Interior.

U. S. ENGINEER OFFICE, Wilmington, N. C., Dec. 12, 1912.—Sealed proposals for dredging in Pamlico and Tar Rivers, N. C., will be received at this office until 12 M., Jan. 11, 1913, and then publicly opened. Information on application. H. W. STICKLE, Maj., Engrs.

Proposal for Construction of Sewers

VILLAGE OF LARCHMONT, WESTCHESTER COUNTY, NEW YORK.

NOTICE IS HEREBY GIVEN, pursuant to law, that the Board of Trustees of the Village of Larchmont, in the County of Westchester, State of New York, will on the 15th day of January, 1913, at 8:30 o'clock P. M., at the Village Hall in said Village, receive sealed proposals for the construction of sewers authorized at the annual election, held on June 18, 1912, to be constructed in said Village.

Conditions under which all said proposals shall be made, the Specifications, plans and detail drawings for the construction of said sewers and the form of Contract under which said sewers are proposed to be constructed may be obtained at the office of L. E. Van Etten, Esq., Engineer, at Nos. 12 & 14 Lawton Street, New Rochelle, New York.

Dated, Larchmont, New York,
December 11, 1912.

By order of the Board of Trustees of the Village of Larchmont,
EUGENE D. WAKEMAN,
Clerk.

Hospital Building Addition

Oxford, N. Y.

NOTICE TO CONTRACTORS.

Sealed proposals for addition to Hospital Building, construction; heating; plumbing, and electric work, at the New York State Woman's Relief Corps Home, Oxford, N. Y., will be received by Mrs. Georgiana Griffith, President of the Board of Managers, New York State Woman's Relief Corps Home, Oxford, N. Y., until 11:00 A. M. Friday, January 3, 1913, when they will be opened and read publicly. Bids are to be received for each division of the work separately, and no combination of bids will be considered.

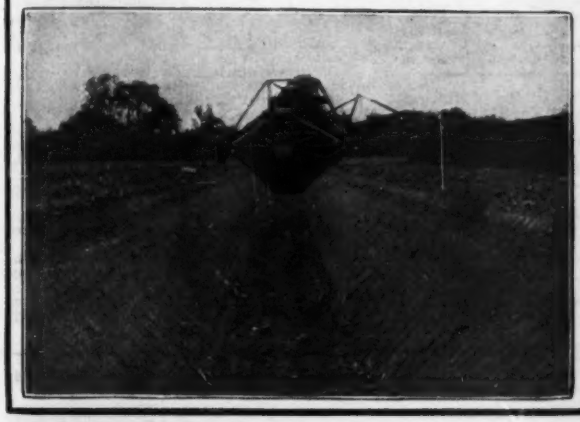
Proposals shall be accompanied by certified check in the sum of 5 per cent. of the amount of bid, and the contractors to whom the awards are made will be required to furnish surety company bonds in the sum of 50 per cent. of the amount of contracts within 30 days after official notice of the award of contract and in accordance with the terms of specification No. 12070. The right is reserved to reject any or all bids.

Drawings and specifications may be consulted and blank forms of proposal obtained at the New York State Woman's Relief Corps Home, Oxford, N. Y., and at the office of the State Architect. Complete sets of plans and specifications will be furnished to prospective bidders upon reasonable notice to and in the discretion of the State Architect, HERMAN W. HOEFER, Capitol, Albany, N. Y.

DEPARTMENT OF THE INTERIOR, U. S. RECLAMATION SERVICE, Washington, D. C., December 7, 1912.—Sealed proposals will be received at the office of the United States Reclamation Service, Malta, Montana, until 2 o'clock P. M., January 10, 1913, for the construction of about two miles of the Dodson North Canal, Milk River Project, Montana. The work involves the excavation of about 205,000 cubic yards of material and is situated on the north side of Milk River and adjacent to the main line of the Great Northern Railway near Wagner and Exeter, Montana. For particulars, address the United States Reclamation Service, Washington, D. C., Helena, Montana, or Malta, Montana. A. P. DAVIS, Acting Director.

You Can Underbid and You Can Outwork Competition with Austin Trenching Machines with Bank Sloping Attachment

Any Man familiar with practical drainage work will appreciate the versatility of the one machine that will dig, first, pipe line trenches to 3 ft. wide, 12 ft. deep and then, sloping bank ditches to 5½ ft. deep, top width 14 ft.



Any Man familiar with his territory can easily see how jobs can be "bunched" so that this machine can be kept constantly on the move, constantly earning its price over and over. One operator and one helper run everything.

The General Construction of this machine is steel throughout, alloy steel gears, the "wearings," such as bushes and pins on the excavator frame, multipedal traction links as well as the digging spuds on the self-cleaning buckets, are manganese steel. The engine is thoroughly reliable.

For full details—Catalog No. 202.

F. C. Austin Drainage Excavator Co.

Railway Exchange, Chicago, Ill.

Improved Austin Drainage Excavator

"No more expensive to operate than steam shovels"

says one contractor, speaking of AUSTIN DRAINAGE EXCAVATORS. With one of his Austins he cuts 32,000 cu. yds. of earth in one month (not counting 4 *shifts*)—with another 22,000 cu.yds. of cement gravel, working *day shifts only*. He says these figures are *typical* and that the low *cost items* are even more interesting.

Soil makes no difference to Austin Excavators. Their manganese-tipped, self-cleaning buckets are called on to bear *minimum wear* because an arrangement tilts them DOWN AND FORWARD as they bite, avoiding the *scraping* that *quickly* wears out all other dirt excavators. This detail is typical of the perfection of these machines. If YOU want perfect ditches, perfect in bank, bottom, berm, spoil, alignment and DURABILITY

Send for Records and Catalog C

F. C. Austin Drainage Excavator Company

Agents Wanted in Open Territory **Railway Exchange, Chicago, Ill.**

Paving

Clinton, Iowa.

SEALED PROPOSALS will be received at the office of City Clerk, Clinton, Iowa, until 8 o'clock P. M. on the 14th day of January, 1913, for a street improvement consisting of the following approximate quantities:

36,800 sq. yds. concrete or brick paving.

11,000 lineal feet combined curb and gutter.

Certified check, $1000.00.

Plans and specifications and forms on file with the City Clerk or City Engineer.

C. J. REUSCHE,
City Clerk.

J. G. THORNE,
City Engineer,
317 Howes Block.

U. S. ENGINEER OFFICE, 415 Customhouse, Cincinnati, Ohio, Nov. 26, 1912.—Proposals for use of U. S. land and unused water at U. S. Dams 3, 4, 5 & 6, Muskingum River, at Lowell, Beverly, Luke Chute, and Stockport, Ohio, respectively, in whole, or in part, for twenty-two years, will be received here until 10 A.M., Dec. 31, 1912, and then opened. Details on application. L. H. RAND, Maj., Engrs.

U. S. ENGINEER OFFICE, Wilmington, N. C., Dec. 7, 1912.—Sealed proposals for furnishing f.o.b. cars, Wilmington, N. C., about 1,000 tons of steel sheet piling for Lock and Dam No. 1, on Cape Fear River at Kings Bluff, N. C., will be received at this office until 2 P. M., Dec. 26, 1912, and then publicly opened. Information on application. H. W. STICKLE, Maj. Engrs.

U. S. ENGINEER OFFICE, Jacksonville, Fla., November 27, 1912.—Sealed proposals for dredging and rock excavation in channel from Clearwater Harbor to Tampa Bay, Florida, will be received at this office until 12 o'clock noon, December 30, 1912, and then publicly opened. Information on application. J. R. SLATTERY, Capt. Engrs.

DEPARTMENT OF THE INTERIOR, U. S. RECLAMATION SERVICE, Washington, December 13, 1912.—Sealed proposals will be received at the office of the United States Reclamation Service, Los Angeles, California, until 2 o'clock p.m., January 22, 1913, for furnishing hydraulic and electrical apparatus for St. Mary Storage Unit, Milk River Project, Montana. For particulars address U. S. Reclamation Service, 605 Federal Building, Los Angeles, California, or Washington, D. C. A. P. DAVIS, Acting Director.

U. S. ENGINEER OFFICE, 327 Federal Building, Detroit, Mich., November 25, 1912.—Sealed proposals for excavating a lock pit at Sault Ste. Marie, Michigan, will be received at this office until 12 M., December 31, 1912, and then publicly opened. Information on aplication. MASON M. PATRICK, Lt. Col., Engineers.

U. S. ENGINEER OFFICE, Wilmington, N. C., Dec. 10, 1912.—Sealed proposals for furnishing and delivering long leaf pine piling for the construction of Lock and Dam No. 1, at Kings Bluff, N. C., will be received at this office until 12 M., Jan. 9, 1913, and then publicly opened. Information on application. H. W. STICKLE, Maj., Engrs.

FORT TOTTEN, N. Y.—Sealed proposals for constructing macadam roads, cement walks, etc., at Fort Totten, N. Y., will be received here until 2 P. M., Jan. 15, 1913, and then publicly opened. Information furnished upon application to QUARTERMASTER.

TREASURY DEPARTMENT, OFFICE OF THE SUPERVISING ARCHITECT, Washington, D. C., December 16, 1912.—Sealed proposals will be received at this office until 3 o'clock p. m. on the 6th day of January 1913, and then opened, for an electric passenger elevator in the United States post office, Portland, Me., in accordance with the drawing and specification, copies of which may be obtained at this office at the discretion of the Supervising Architect. OSCAR WENDEROTH, Supervising Architect.

FABRICATED STEEL AND FIELD RIVETS—Sealed proposals will be received at the office of the Purchasing Agent, Bureau of Supply, Manila, P. I., until 8 a.m., January 15, 1913, and at the office of the Insular Purchasing Agent, Bureau of Insular Affairs, Room 1530, 17 Battery Place, New York City, N. Y., U. S. A., until 7 p.m., January 14, 1913, and then publicly opened, for furnishing all the fabricated steel and field rivets for:

Two spans at 90'0"
One span at 100'0" } for Nueva Ecija
One span at 130'0" } bridges

Seven spans at 160'0" for the Laoag Bridge, Ilocos Norte.
One span at 160'0" for the Rugao Bridge, Isabela,

for the Government of the Philippine Islands.

Envelopes containing proposals should be plainly marked "Proposal for Fabricated Steel for Nueva Ecija, Laoag, and Rugao Bridges."

Instructions to bidders, general conditions, proposals, plans and specifications may be obtained and examined at the office or offices above named. Additional information will be furnished upon application.

Bidders are requested to be present at the time stated above when bids for the work will be opened.

Address all communications to "The Purchasing Agent, Bureau of Supply, Manila, P. I.," or "Insular Purchasing Agent, Bureau of Insular Affairs, Room 1530, 17 Battery Place, New York City, N. Y., U. S. A."

ADDITIONAL PROPOSAL ADVERTISEMENTS ARE ON PAGE 46

Ask Any Famous Architect—

what he thinks of **"Koh-i-noor"** Pencils and Tracing Cloth. He will tell you they are without a peer. The great architects, almost without exception, use **"Koh-i-noor"** Pencils and **"Koh-i-noor"** Tracing Cloth because they find them more satisfactory in every way than other makes—because high grade work must be done with high grade materials.

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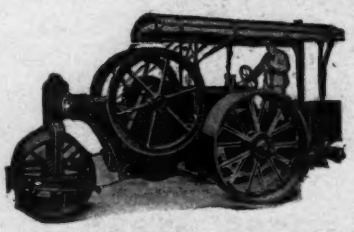

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NO WATER TEAMING

We also manufacture: Rock Crushers, Road Graders, Scarifiers, Sprinklers, Sweepers, etc.

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FOOTE BATCH MIXERS

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EVERY FOOTE A MIXER

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ARE IN USE ON

Houses, warehouses and factories.
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Tanks, silos, and grain bins.
Sewers, aqueducts and drains.
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Our experience in furnishing forms for over 6,000 contracts is at your service.

WRITE US ABOUT YOUR WORK AND WE WILL SEND YOU LITERATURE ON THE SUBJECT.

Blaw Steel Construction Company
GENERAL OFFICES:
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Chicago—917 Ashland Block New York—165 Broadway

The "Second Best" Wagon

Ask the next five dump wagon salesmen you see, what wagon they consider "second best" and see what they tell you. Watson salesmen are barred on this test, of course. Try it.

Watson Wagon Co., Canastota, N. Y.
"The World's Largest Dumping Wagon Builders"

Branch Offices:
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There's Longer Wear In Eagle Dump Wagons

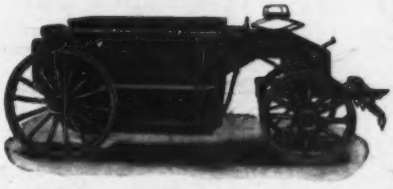
Larger wear, because we put such good material and workmanship into them.

You are safe if you stipulate Eagle Dump Wagons. They are widely known and sold in car lots to contractors who want the best service plus the highest economy.

Write for the Eagle Booklet.

The Eagle Wagon Works
Auburn, New York

An Interesting Re-Order



Last year Levy & Levy of Muskogee, Oklahoma bought ten (10) TROY Asphalt Wagons. They had tried out every other asphalt wagon on the market—to their sorrow. G. A. Heman of St. Louis told them to buy TROYs. He had been through the same experience and TROYs had solved his problem.

On December 9th, Levy & Levy ordered ten more TROYs by mail—unsolicited. Their letter said their wagons were absolutely satisfactory and just what they had been looking for.

How about you? Better get Catalog 2N and let us make you a price.

The Troy Wagon Works Co.
Race and Walnut Streets TROY, OHIO

FILTERS

GRAVITY and PRESSURE TYPES

Owners of the
NEGATIVE HEAD FILTER PATENT

LICENSEES
Pittsburgh Filter Mfg. Co.
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Write for booklet "Mechanical Filtration"

THE NEW YORK CONTINENTAL JEWELL FILTRATION COMPANY
111 Monroe Street, CHICAGO **15 Broad Street, NEW YORK**

The Way to Good Country Roads Is to Surface Them with Warrenite

Stop and think what you are now spending repairing your worn-out Macadam Roads.

Is it economy to continue this maintenance expense when Warrenite the permanent country road surface can be had at a low cost?

WARRENITE is a modified form of the BITULITHIC STREET pavement adapted to meet the conditions which prevail on country roads and the requirements of the modern automobile traffic.

Warrenite country road surface can be laid on either old macadam or concrete base.

WARRENITE is being adopted from coast to coast. Fall in line and surface your conutry roads with WARRENITE surface, which can be had at such a reasonable cost.

WARRENITE is a country road surface which has proven to be the best for country road automobile and horse traffic, and is most economical, durability considered.

All contractors experienced in the building of highways may compete for contracts for the Warrenite road surface, purchasing from us at our plant, located near the work, the surface material ready to be laid as they would purchase paving blocks from the manufacturers of the blocks.

Write today for WARRENITE circulars, specifications and form of Mixture License Agreement available to all contractors, and learn more about this modern ideal, permanent country road surface.

WARREN BROTHERS COMPANY
Executive Offices - - - 59 Temple Place, Boston, Mass.
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New York, N.Y. 50 Church St. — Chicago, Ill. 10 So. LaSalle St. — Rochester, N. Y. 49 West Ave. — Los Angeles, Cal. 926 Calif. Bldg. — Portland, Oregon, Journal Bldg.

What One Contractor Accomplished with

HOTCHKISS
STEEL CURB AND GUTTER FORMS

Lineal feet built, 9983. Time, 200 hours. Labor force, 16 men. Forms used, 160 ft. **Labor Cost, 8.3 cents per lineal foot.** Users of wooden or any other forms, match it if you can! Write for free booklets.

HOTCHKISS LOCK METAL FORM CO.
Dept. N. **Binghamton, N. Y.**

A Pavement As Smooth As Asphalt—Ten Times The Wear

Made possible by the quarrying of a particularly fine grained granite. As smooth as asphalt unaffected by heat—don't wear out.

GRANITE
Paving Blocks

Quarries:—Vinal Haven, Maine, Alexandria Bay, N.Y.

Our quarries are fully equipped with modern derricks and machinery. We are prepared to make prices for export. Can ship by rail or water promptly to any destination. Write

J. LEOPOLD & CO., 18 Broadway NEW YORK
Cable Address: Granite, N. Y.

The Miller Siphon
For Flushing Sewers

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SEWAGE DISPOSAL AIR-LOCK CONTROLS

Send for Catalog — *Write for Discount*

Pacific Flush-Tank Company
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Complete Facilities for Testing and Inspection of Materials, Technical Investigations, Process Work, etc.

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SEWER and SUBWAY MANHOLE CASTINGS
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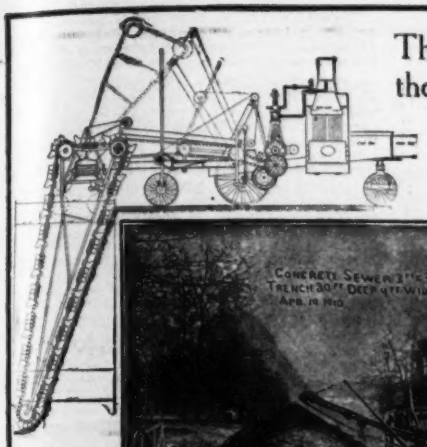
—TO ORDER—



The Parsons Trench Excavator is appreciated most by those that have used it the longest, and who continue to use it day after day.

Our satisfied customers helped to build our business. Most any trench excavator manufacturer can give you good arguments in favor of his machine. **We prefer to give you good service and in that way let the machine settle the matter as to its durability, speed, economy, adaptability, and great money earning power.**

Inefficient machinery is expensive to operate, wastes time and labor and eats into your profits. The Parsons makes you the largest profits, because it does the best work, in the shortest time, at the least cost. **If you want to do more and better work, and make bigger profits put a Parsons Trench Excavator on your next job.**

It excavates any trench from twenty-eight to seventy-eight inches in width, and any depth to twenty feet.

Send for our latest catalog which describes the Parsons in detail.

THE G. W. PARSONS COMPANY Newton, Iowa.

TRENCH MACHINES

We sell and lease All Kinds of Hoisting and Conveying Machines for Trench Work.
Catalogue Sent Upon Request.

Carson Trench Machine Co., Boston, Mass.
BRANCH OFFICES: Rose Building, Cleveland; 318 St. James St., Montreal.

Garbage Disposal Plants

Dryers, Condensers and Percolators. Elevators, Conveyors and Tanks
Complete Plants for Large or Small Cities
THE C. O. BARTLETT AND SNOW CO.
CLEVELAND, OHIO, U. S. A.

BLEACHING POWDER
(Chloride of Lime)
For Purifying Water and Sewage Disposal.
HOOKER ELECTROCHEMICAL CO.
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A Trench Digger wi hout a differential, friction clutch or complicated gearing or mechanism to get out of order.
IT'S THE "MONAHAN"
And this is only *one* of several respects in which THE MONAHAN is different and better. If you are interested in trench digger efficieney, it will surely pay you to send for a copy of the "Monahan Trench Digger Booklet" and get full details.
W. J. Heggie - - - - Joliet, Ills.
Chicago Office, 900 Old Colony Building

You can cut blasting costs by the
Keystone Way

Much better than an undecided, haphazard choice of explosives is to put your problem up to a board of men who *know* blasting—who specialize on it.

Keystone has such a board. **Maintained** for your consultation—service gratis.

The U. S. Government is hard to please yet it has used 25,000,000 lbs. of Keystone in building the Panama Canal.

Keystone National Powder Co.
Emporium, Pa.

Sewer in Compressed Air Tunnel

PASSAIC VALLEY SEWERAGE COMMISSIONERS
Newark, N. J.

NOTICE TO CONTRACTORS:

Notice is hereby given that the Passaic Valley Sewerage Commissioners have designated Tuesday, the fourth day of February, nineteen hundred and thirteen, at two o'clock in the afternoon, as the time when they will meet at their usual place of meeting, Essex Building, Clinton Street, Newark, New Jersey, to receive proposals, in writing, for the construction of Section 7 of the Main Intercepting Sewer, in compressed-air tunnel, in the City of Newark, New Jersey.

Particulars that may enable Contractors to judge of the character of the work are given below:

APPROXIMATE QUANTITIES: Section 7.

Item 1. Excavation in Earth, Rock, or Rock and Earth together, in compressed-air tunnel, for 135-inch circuflar concrete sewer, and all appurtenant work, 4930 linear feet.

Item 2. Excavation in Earth, Rock, or Earth and Rock together, in compressed-air tunnel, for 141-inch circular concrete sewer, and all appurtenant work, 8800 linear feet.

Item 3. Concrete masonry, in compressed-air tunnels and shafts, made with Portland cement mortar, and including all appurtenant work.....30,000 cubic yards.

Item 4. Brick masonry, in shaft manholes, laid with Portland cement mortar, and all appurtenant work.....300 cubic yards.

Drawings, form of contract and specifications, and blank form for proposal may be obtained at the commissioners' office from William M. Brown, Chief Engineer.

The Commissioners reserve the right to reject any or all bids.

PASSAIC VALLEY SEWERAGE COMMISSIONERS.
JOHN S. GIBSON, Clerk.
December 17, 1912.

Surfacing Highways

CATSKILL AQUEDUCT
CONTRACT 134

SEALED BIDS will be received by the Board of Water Supply, at its offices, seventh floor, 165 Broadway, New York, until 11 A. M. on Tuesday, January 21, 1913, for Contract 134 for surfacing with vitrified brick block, highways around the Ashokan reservoir, in the towns of Olive, Marbletown, Hurley, Woodstock and Kingston, Ulster County, New York.

At the above place and time the bids will be publicly opened and read. Pamphlets containing information for bidders, and contract drawings can be obtained at the above address by depositing the sum of Ten dollars ($10.) for each pamphlet. For further particulars see information for Bidders.

CHARLES STRAUSS,
President,
CHARLES N. CHADWICK,
JOHN F. GALVIN,
Commissioners of the Board of Water Supply.
JOSEPH P. MORRISSEY,
Secretary.

U. S. ENGINEER OFFICE, Jacksonville, Fla., Dec. 23, 1912.—Sealed proposals for furnishing material and raising jetty at entrance to St. Johns River, Fla., will be received at this office until 12 o'clock noon, Jan. 23, 1913, and then publicly opened. Information on application. J. R. SLATTERY, Capt. Engrs.

Wants

Mechanical and Electrical Engineers

M. J. ULRICH, M. E., Member A. S. M. E. and Verein Deutscher Ingenieure; 18 years chief engineer and chief draftsman for the Deane Steam Pump Co., Holyoke, Mass.; 10 years mechanical engineer and chief draftsman for the Alberger Condenser Co., New York City; due to business consolidation is open to proposition for a position; has most reliable character and extraordinary ability in steam, condensation, evaporation, pumping machinery, designing and manufacturing, superintendence; references as above; New York City or vicinity preferred. Address 570 West 182d St., New York.

MECHANICAL ENGINEER, 12 years' experience design, construction and repair dredges and contractors' plant; employed; references. Box 744, Eng. News.

Civil Engineers

GRADUATE ENGINEER desires position; railroad maintenance and construction, water supply, steam and hydro-electric plants, heavy electric traction, operation and earning reports, shops and terminals. Box 588, Eng. News.

CIVIL ENGINEER, 35; ten years' continuous experience on public works; railroad location and construction; good knowledge Spanish; South, or Latin America preferred; after Dec. 20. Box 769, Eng. News.

1904 GRADUATE C. E., experienced in structural design and construction, office and field; good executive; desires responsible position with general contractor. Box 775, Eng. News.

CIVIL ENGINEER, 12 years' experience in responsible charge, railways, municipal engineering, real estate development, state highway construction; South or West preferred. Box 779, Eng. News.

CIVIL ENGINEER, over ten years' continuous and varied employment; field and office; mostly with present employers, trunk line railway, on maintenance, structural work and in charge on construction, desires change. Box 823, Eng. News.

GRADUATE ENGINEER, eight years' experience on railway and general engineering work, mostly in charge, is willing to accept, moderate salary for permanent position; best references; railway or development work preferred. Box 822, Eng. News.

CIVIL ENGINEER, age 36, technical, 15 years' experience railroad preliminary, location, construction, valuation, chief draftsman, assistant engineer, contractors' engineer and superintendent, municipal, industrial and U. S. river and harbor improvement; can design, detail and superintend construction. Box 815, Eng. News.

GRADUATE ENGINEER, five years' experience railroad land, bridge, seeks opening chief of party, any location. Box 814, Eng. News.

CIVIL ENGINEER, American, graduate German Technische Hochschule, two years' experience in railroad and hydraulic engineering, wants position. Box 817, Eng. News.

Bridge and Structural

STRUCTURAL ENGINEER, with 12 years' experience in building and bridge work, reinforced concrete, desires position as designer. Box 818, Eng. News.

Surveyors

EXPERIENCED INSTRUMENTMAN, draftsman, desires position. Box 793, Eng. News.

Draftsmen

YOUNG MAN, technical education, now employed as tracer, seeks similar position with construction concern; salary and location immaterial. Box 812, Eng. News.

STRUCTURAL DRAFTSMAN, graduated civil engineer, with 3½ years' experience on bridge and structural work, desires position in New York City. Box 824, Eng. News.

Superintendents etc.

ENGINEERING SALESMAN—Position wanted by college graduate; eight years' experience; best references. Box 768, Eng. News.

RESPONSIBLE POSITION wanted by expert reinforced-concrete designer and estimator; ten years' experience; general structural engineer. Box 743, Eng. News.

CONTRACTORS' ENGINEER, Assoc. M. Am. Soc. C. E., technical graduate; wide experience structural steel, reinforced concrete, foundations, all branches building construction and estimates; good executive; minimum salary, $5000; New York interview. Box 808, Eng. News.

CONTRACTING ENGINEER, designer and draftsman, with extensive and successful experience in securing orders for structural steel, truss construction, etc., desires change of position; can promptly design work in field; complete, accurate estimates of shop costs and close contracts; A1 reference Address Engineer, 211 Atlantic Ave., Atlantic City, N. J.

GENERAL SUPERINTENDENT of building construction, 20 years' experience; have had charge of large operations in New York City and elsewhere; will locate anywhere. Box 816, Eng. News.

CARPENTER-FOREMAN on reinforced concrete construction wants position; eight years' experience; any system; best references. Box 819, Eng. News.

Situations Open

SEVERAL FIRST-CLASS CHECKERS AND DETAIL DRAFTSMEN wanted on structural work; no others need apply; give experience, references, salary expected and when available first letter. Box 754, Eng. News.

EXPERIENCED MANAGER wanted to take charge of manufacturing machine and carpenter shop; one who is familiar with modern shop practice and systems and who is capable of reorganizing a shop doing a business of $300,000 a year; state experience, salary expected and give reference. Box 777, Eng. News.

DRAFTSMEN wanted at once; men familiar with traction engine, steam roller, concrete mixer, or similar work; steady work for right men. Box 783, Eng. News.

DRAFTSMAN — Company building large line of centrifugal pumps wants man to take charge of drafting room; must be familiar with designing of high-speed turbo-type pumps. Box 786, Eng. News.

ENGINEER wanted with practical experience supervising the running and construction of large plant, as assistant to chief engineer and represent him during his absence; must be able to take charge of drawing room and design of building and machinery; knowledge of manufacturing sugar preferred; state previous experience, age and salary desired. Box 820, Eng. News.

MANAGER of New England factory seeks an assistant technical graduate with actual experience in manufacturing; state age, experience and pay received in former positions. Box 821, Eng. News.

STRUCTURAL ENGINEERS—One or two engineers, experienced in design and construction of factory buildings. Apply by letter, giving education, experience, references and salary expected, Turner Construction Co., 11 Broadway, New York.

Miscellaneous Wants

PAVING—Position desired by engineer as representative paving company; experience on both construction and promotion; best references. Box 764, Eng. News.

GOOD NEWS awaits R. D. Rathburn, if he will communicate with Knudlem, Enid, Okla.

TEN-TON TRUCK wanted, new or second-hand, suitable for mounting a hoisting engine on. Box 815, Norfolk, Va.

CIVIL GRADUATE, 27, five years' construction experience, desires connection with contractor; estimator, field assistant, business getter; small investment. Box 813, Eng. News.

SECOND-HAND 15-in. hydraulic dredge machinery in first-class condition for immediate delivery; in reply state make, length of time in service, where it can be seen, price and other pertinent information Box 811, Eng News.

SECOND-HAND 65- or 70-ft. boom drag-line excavator, 1½-yd. bucket; give price, location, make and earliest delivery. Box 810, Eng. News.

ONE SECOND-HAND standard gage double truck locomotive crane wanted; boom, 35 to 50 ft. long, equipped with two-rope, 1½- to 2-yd. clamshell bucket; capacity of crane, bucket full of wet sand at maximum radius; motive power, steam; inclosed cab. Box 809, Eng. News.

YOUNG ENGINEER, steady, reliable, energetic, wants Philadelphia representation for progressive manufacturing concern. Box 776, Eng. News.

WANTED TO PURCHASE, a five- to seven-ton steam roller for rolling brick pavements; will pay cash if price is reasonable. Box 801, Eng. News.

WANTED—Young college graduate (either 1912 or 1911) engineer, to take financial interest with contractor, with over 20 years' experience, operating in New York City and vicinity. Box 780, Eng. News.

Agencies and Bureaus

MECHANICAL DRAFTSMEN—We always have calls for such men; communicate with Mr. Harrison, The Engineering Agency, Inc., Monadnock Block, Chicago.

SEVERAL DRAFTSMEN and engineering graduates wanted. Cleveland Engineering Agency, Cleveland.

For Sale

ENGINERING NEWS, bound in half leather, years 1898 to 1911, inclusive, 28 volumes at $3.25 per volume, or $85 for the set; also transactions of American Society of Civil Engineers, bound, from 1888 to 1812, inclusive. Alex. E. Kastl, 127 Delaware Ave., Albany, N. Y.

AMERICAN PATENT (issued some time ago) for utilizing steam engine exhaust for feed, is offered for sale for $20,000, the inventor lacking means; in a test plant 40% coal was saved against atmospheric exhaust; the plant works perfectly. Address N. S. 2805, care of Rudolf Mosse, Berlin, S. W. 19, Germany.

Second Hand Transits And Levels For Sale

2—No. 2 A "Buff" Transits with level to telescope.
2—Gurley Transits with level to telescope.
2—Gurley Engineer's Wye Levels.
2—Stackpole Engineer's Wye Levels.

Send for our complete list.

The Engineering Agency, Inc., Monadnock Block, Chicago

For Sale

One 65 ton Vulcan Steam Shovel, 2¼ yd. dipper, air brakes, in absolute perfect order, just out of shop having been thoroughly overhauled. For sale at a bargain. We carry a large supply of contractors equipment. Favor us with your inquiries.

Frank T. Craven **30 Church St., New York City**

FOR SALE

Conveyor Rollers and Framework

2 sets each of rollers and framework for 60′ x 36″; 95′ x 32″; 112′ x 32″, Robins Conveyors, complete. One set of rubber belts, complete, for above conveyors.

Motors

2—10 H. P., 220 V., 665 R. P. M.
2—15 H. P., 220 V., 1012 R. P. M.
2—15 H. P., 220 V., 1040 R. P. M.
2—25 H. P., 220 V., 765 R. P. M.

For further information, address

Empire Engineering Corporation

707 White Building **Buffalo, N. Y.**

When you are in a hurry for an engineer, surveyor, draftsman, or in fact any technical man, a Situation Open ad. in ENGINEERING NEWS will place you in touch with the largest number of men in the shortest time. Advertisements received Wednesday morning will be inserted in the Situation Open columns of the issue of the following week.

FOR SALE

New and Used Concrete Mixers and Hoisting Engines of all kinds for immediate delivery, will sell at a sacrifice. Get our prices before buying.

CHICAGO BUILDERS' SPECIALTIES CO.

Old Colony Building **Chicago, Ill.**

The Article You Most Want To Read

The article that is of most value to you in your work and your profession is bound to be in that copy of ENGINEERING NEWS which you miss.

It's the contrary nature of things. It's the story of the last match and the only train and the collar-button and the dinner party.

So don't let Gaps occur in your file of ENGINEERING NEWS. Keep it complete.

Renew your subscription before it expires. Why not send it in now while the thought's in your mind?

Western Advertisers

may have their WANT and FOR SALE Advertisements KEYED TO OUR

Chicago Office
1138 Monadnock Block

and in that way save considerable time in forwarding.

Want Ads received at our Chicago Office on the Saturday preceding publication will be inserted in classification.

Second Hand Equipment

Plate Girder Spans In Stock For Sale:

We have stored at our Memphis plant several Girder Spans, as listed below, which were manufactured for a Southern R.R. extention on which work has been temporarily suspended.

Cooper's E-50 Loading, Specifications 1906.

Two Deck Spans 92′ 6″ and One Deck Span 82′ 6″.
92′ 6″ o to o of Girders.
82′ 6″ o to o of Girders.
Girders 7′ 0½″ Deep Back to Back of Angles
Girders 8′ 0″ c to c
10′ 0″ Base of Rail to Masonry
Pin Shoes
Weight of 82′ 9″ Span, 89,680 lb.
Weight of 92′ 6″ Span, 113,445 lb. each

Five Deck Plate Girder Spans 80′ Each.
80′ 0″ o to o of Girders
Girders 7′-½″ Deep Back to Back of Angles
Girders 8′ c to c
9′ 6½″ Base of Rail to Masonry
Pin Shoes
Weight 87,250 lb.

Two Through Plate Girder Spans 80′ 0″.
80′ 0″ o to o of Girders
Girders 7′ 6½″ Deep Back to Back of Angles
Girders 15′ 2″ c to c
14′ 0″ in Clear
4′ 8″ Base of Rail to Masonry
Pin Shoes
Weight 120,560 lb. per span

One Deck Plate Girder Span 60′ 0″.
60′ 0″ o to o of Girders
Girders 6′ 0½″ Deep Back to Back of Angles
Girders 6′ 6″ c to c
6′ 9½″ Base of Rail to Masonry
Weight 47,000 lb.

One Through Plate Girder Span 60′ 0″.
60′ 0″ o to o of Girders
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Girders 14′ 4″ c to c
3′ 1″ Base of Rail to Masonry
13′ 2″ in Clear
Weight 72,115 lb.

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Changes for 1913

With the first issue of the new year ENGINEERING NEWS will adopt the changes in style and arrangement outlined below for the convenience and benefit of its readers.

The reading matter type will be larger and set in two columns to the page instead of three—easier to read.

The synopsis of important articles formerly set in black faced type in box heading will hereafter appear as the first paragraph, set in italics.

The Contents will appear on the first page inside the cover and the principal articles will be summarized there in such a way that a busy man can pick out just what he wants and turn to it.

If this page *alone* is read you will at least have an outline of the principal developments in the field of civil engineering and construction work.

The Index will be so arranged that each subject can be cut out for card filing when desired.

The Alphabetical Index of Advertisers will always appear on the last page in the paper (next to the cover) and the Alphabetical Directory of material and equipment advertised in ENGINEERING NEWS, will precede the Advertisers Index.

All of which will make it easy for the reader to use this index in seeking names of articles wanted or those making them.

The editorial page will be found at the end of the general reading matter, about the thirty-second page from the front. This is done to bring these pages into the last forms going to press, thus making it possible to comment on later happenings than heretofore.

We intend to publish the news of the broad field of civil engineering construction work first and best.

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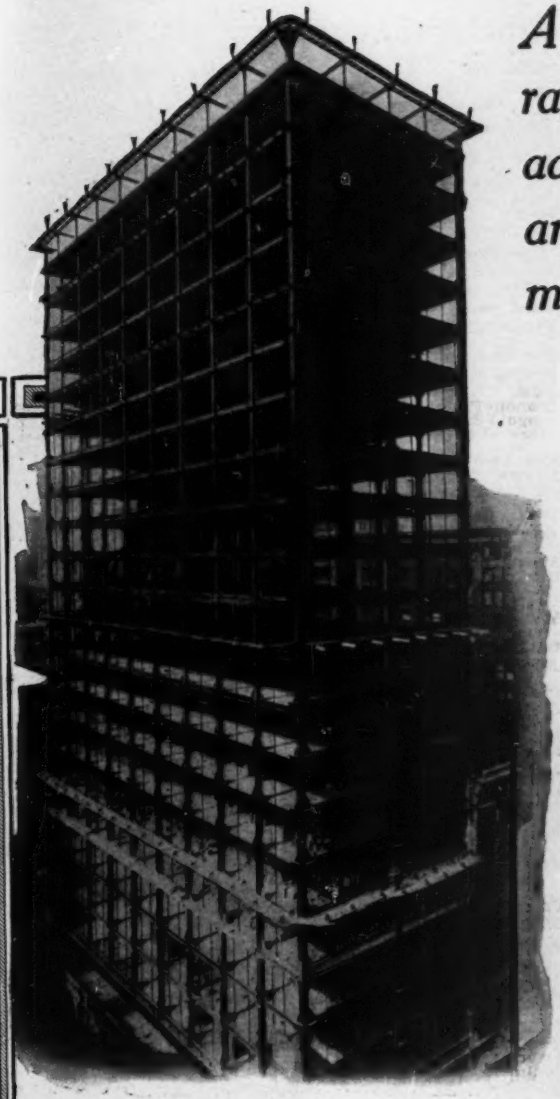

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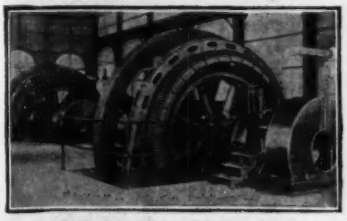
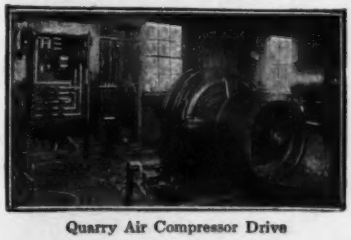
Tidewater Portland Cement Co., Union Bridge, Md.

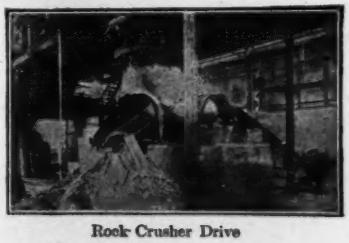
Continuous Economical Operation of Cement Plant by Electric Power



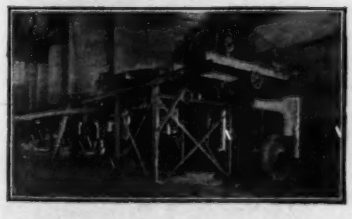
G-E Generators in Power Plant



Quarry Air Compressor Drive



Rock Crusher Drive



Kiln Feed and Blower Drive

The pictures on this page were taken at the Tidewater Portland Cement Company at Union Bridge, Maryland. This company uses individual motors for every machine in their plant.

Every hour the temperature of each motor is observed and power records are kept which enable the management to know at all times the exact cost of power per barrel of cement produced.

Each motor is protected by relays which are set for the proper loading of conveyors, mills, crushers, etc. Should a machine be overloaded, the relay opens the circuit and an electrician must be called to start the motor again.

He makes a quick observation of the load on the motor and, if it is excessive notifies the department fireman to reduce it.

Eighteen months' operation shows no signs of wear on the gears of the back geared motors used on elevator legs.

Practically no contingency can shut down this plant with its duplicate feeders and generators, and it is run at high efficiency even when only a part of the plant is operating overtime.

The complete electric equipment of generators, motors, etc., was furnished by the General Electric Company.

If you would interest capital in your plant there is no incentive like an efficient, dependable electric drive using G-E motors.

Kiln Drive

Ball Mill Drive

Conveyor Belt Drive

Kent Mill Drive

General Electric Company

Largest Electrical Manufacturer in the World

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Denver, Colo. San Francisco, Cal. Sales Offices in all Large Cities.

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Conduit
Johns-Manville Co., H. W. 21

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Ambursen Hydraulic Construction Co. 57
Carter Construction Co. 83
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Link-Belt Co. 70
Ohio Locomotive Crane Co. 66
Robins Conveying Belt Co. 66

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Cranes, Wrecking
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McKiernan-Terry Drill Co. 32
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American Gas Furnace Co. 20

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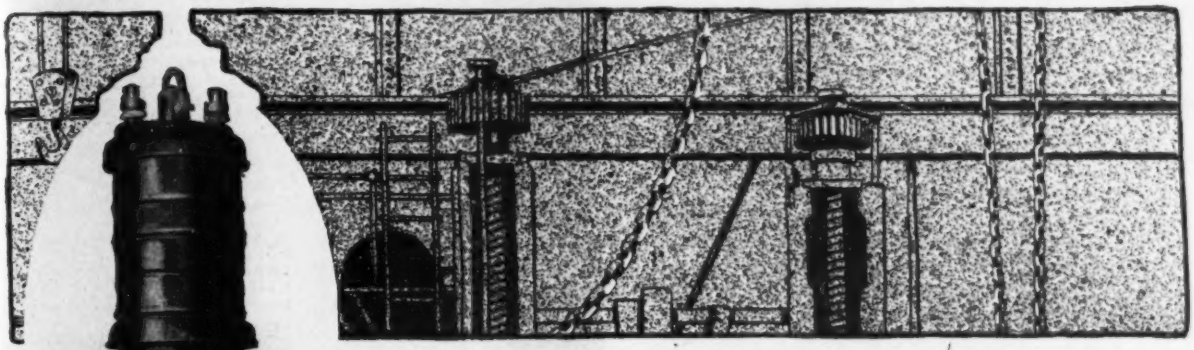

Plan A Lighting System That Makes Scientific Management Possible

A good lighting system is essential to scientific management because artificial light is used from 10 to 40% of the working hours.

Under actual test good illumination increased production 10%, in addition, there was a marked improvement in the quality of the work.

Good illumination also lessens errors, spoilage, accidents and shut-downs, therefore, quality and quantity is still further increased.

The Long Life GE Flame Arc Lamp

(Type W)

is especially recommended because it gives a brilliant, well diffused light over large areas and because of its long electrode life and great economy. On a multiple circuit this lamp will burn for over 100 hours without attention and even then it is necessary to change only one electrode. The novel method of ventilation keeps the globe clean throughout the long electrode life. This lamp is recognized as one of the most powerful lighting units known and can be placed in any standard commercial circuit. It is substantially constructed and reliable in service.

Adequate illumination is engaging the attention of every thinking employer. The services of our experts on scientific illumination are at your command to assist you in your plans for a better system of lighting.

Give your employees an opportunity to become 100% efficient. Write for information describing this lamp in detail.

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The Bassano Dam

The following views will indicate what can be done in the way of erecting a great hydraulic structure on foundations of clay and sand,—not even gravel or, much less, ledge rock. As the canals are not yet completed, the dam cannot be closed until the summer of 1913, although the work on the dam itself was finished in April of this year.

The trestle above the dam is for carrying material to the earth embankment which is fully a mile long.

The flood is controlled by Stoney gates on the crest operated by motors.

A tumbling hearth extends down stream to the toe of the abutment.

The pictures tell the rest of the story. We are pleased to show a photograph of Sir William Willcocks, the builder of the Assouan dam on the Nile. Sir William has been inspecting American and Canadian practice with reference to a large amount of irrigation work on the Euphrates River.

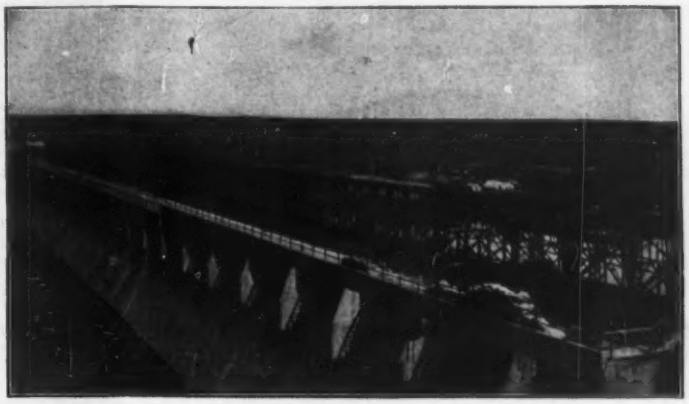

Figure 1—Front of Dam Showing Traveling Crane

Figure 2—End View of Dam Showing Earth Embankment and Gate House

Figure 3—Gallery Through the Interior of Dam

Figure 4—Sir William Willcocks (on the left)

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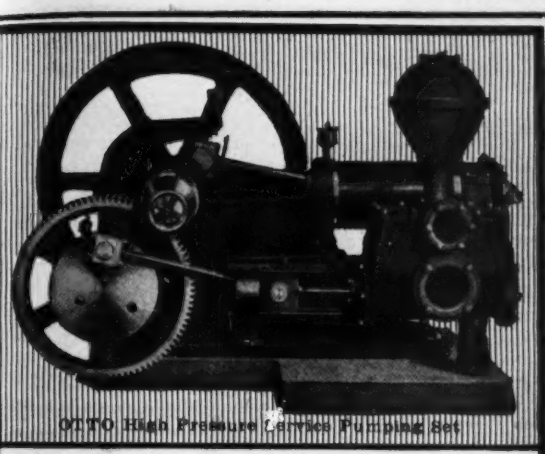

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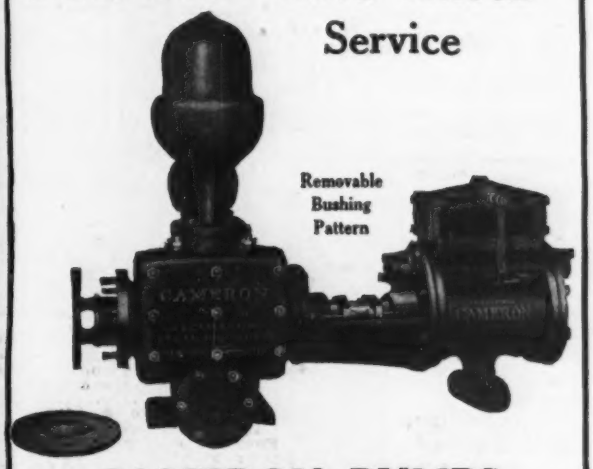

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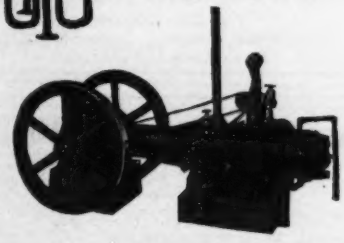

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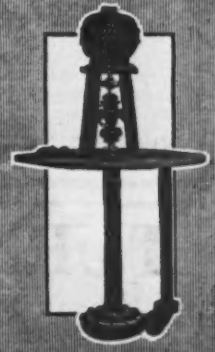

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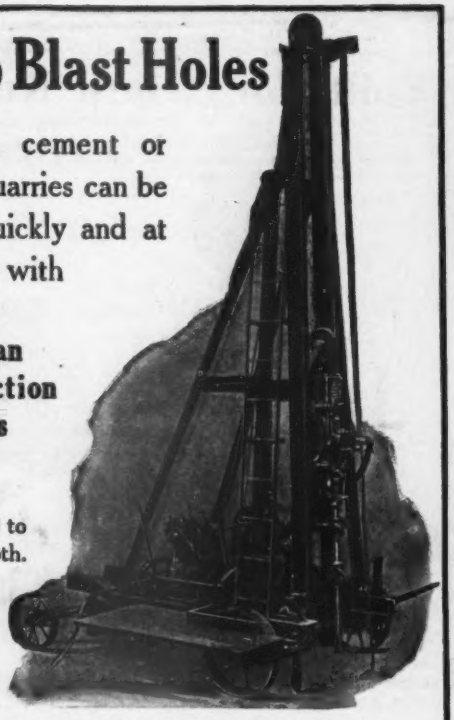

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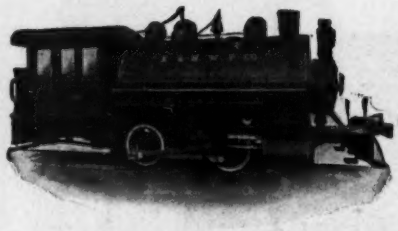

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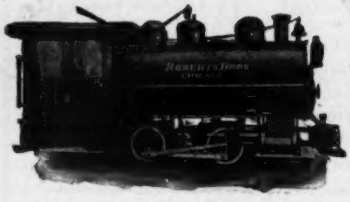

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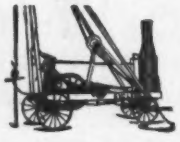

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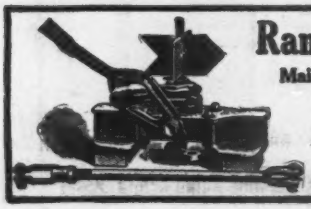

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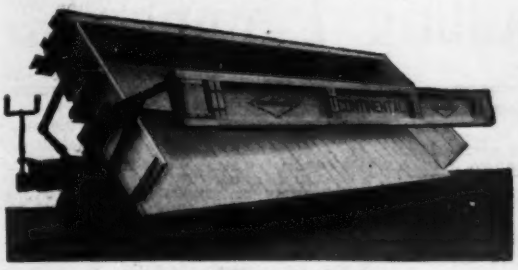

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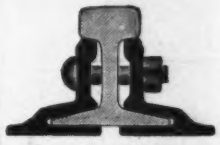

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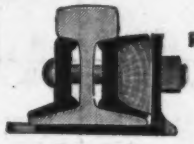

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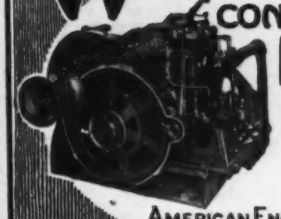

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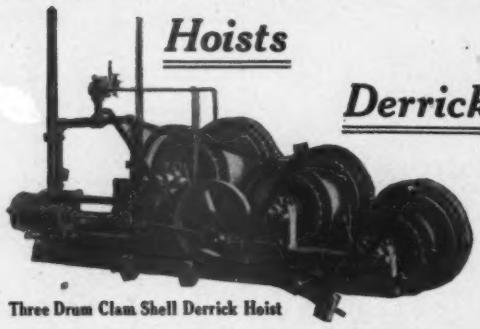

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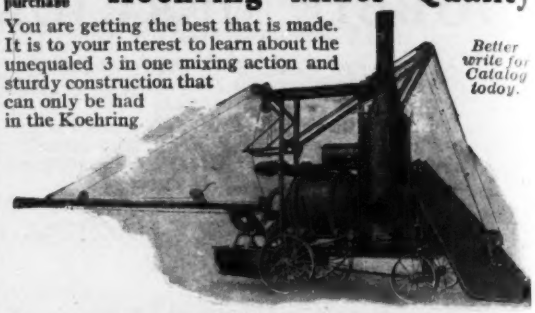

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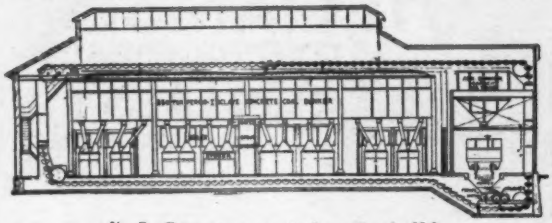

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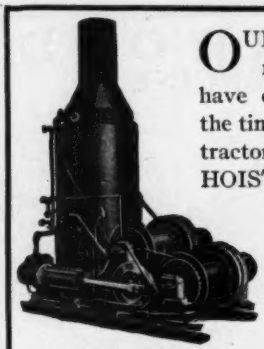

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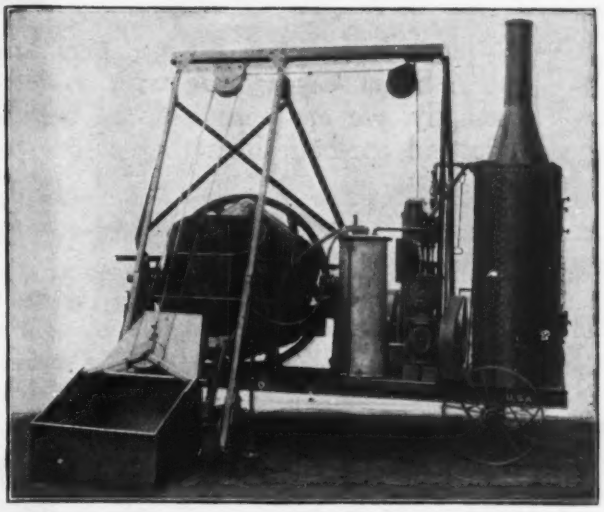

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Greatly Appreciating their Generous
Patronage during the Past Year.

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LET'S PULL TOGETHER AND MAKE IT SO

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OUR plant is found to be inadequate to take care of the demand for Morse Silent Chains, and with a view to being able to handle orders more promptly, we are putting up an addition which will give us a floor space two and one-half times that of our present plant.

The two-pin "Rocker-Joint," exclusive to MORSE Silent Chains, is the reason.

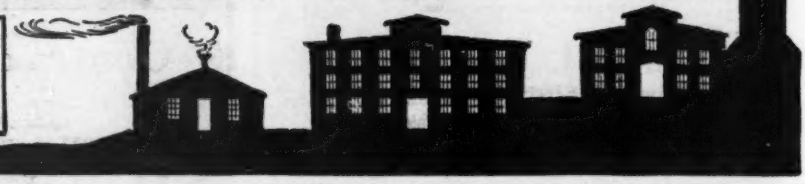
Leave the selection of the drive to any engineer who knows the principle upon which this "rocker-joint" is constructed, and in almost every case he will specify MORSE Silent Chain Drive—he knows MORSE Silent Chains are most efficient *because of this joint.*

Why shouldn't you follow the lead of those engineers?

Are you open to conviction? Will you let us show you how MORSE Silent Chain Drives will save you money? Why not write us today?

Morse Chain Company, Ithaca, N. Y.

REMEMBER:
You can't get this "rocker-joint" in any *other chain.*



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Tested Steel Chain

Don't risk accident with chain you don't know about.

Proof certificate of test given with every order of J & L chain.

Our chain is made from most carefully selected material, under careful supervision—in short, it is J & L quality and workmanship throughout.

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41

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Elevators - Conveyors - Unloaders
"A Ton a Minute"

"B-P" Elevator with Apron Conveyor.

This is a **general purpose** elevator, adaptable to handle bags, cases, crates and miscellaneous packages (excepting barrels).

It is useful in **any** warehouse handling miscellaneous merchandise and will pay for itself in a short time in **actual saving** of non-productive expense.

Always ready for use.
Costs nothing to maintain when idle.

If interested in reducing handling expense Let Us Send You Detailed Information.

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Schieren's Duxbak Waterproof Leather Belting

is especially suitable for jobs where temporary arrangements of pulleys compel many changes in length of belts and where exposure to contact water mixed materials destroy ordinary leather beltings.

Leather is the recognized best material to use for power transmission. It gives the best pulley contact and is capable of perfect splicing by our simple method.

Send for our booklet of instructions on the care of belting. It tells a great deal in a little space.

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Jeffrey Hercules Malleable and Steel Combination Detachable Chain

This Chain is designed especially for extra heavy work in handling Gritty Material in Cement Plants, Chemical and Fertilizer Works, Mines, etc., and is also extensively used in General Elevating and Conveying Work.

Recommended for its great strength, simple construction and on account of the large amount of protected wearing surface.

Practically Dust-Proof, with Malleable Iron Solid Link and Steel Bars, made up with either Riveted or Coupling Pins.

Works upon Standard Sprocket Wheels.

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Hercules Link with Angle Iron Connecting Links

12-26-12

THIS BROWNHOIST LOCOMOTIVE CRANE
deposited one cubic yard of concrete per minute

on the construction of the Fourth Avenue Subway, New York City. This was done day after day with a 2 yd. concrete bucket. Four of these cranes were used on this work by the Tidewater Building Company and Thos. B. Bryson, Contractors. Besides handling the concrete, the cranes were used in excavating, unloading sand and gravel, (65 yds. per hour) and handling all the heavy material.

CONTRACTORS
use the Brownhoist Crane

because it is built of hard and continuous service. Delays are expensive to any contractor and he cannot afford to have a crane that is continually breaking down. The Brownhoist crane is used by contractors in all parts of this country and we want you to investigate its record. Ask the man who has one.

Our catalog shows the Brownhoist crane as used on contract work. Send for it today.

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Hoisting Machinery Co.
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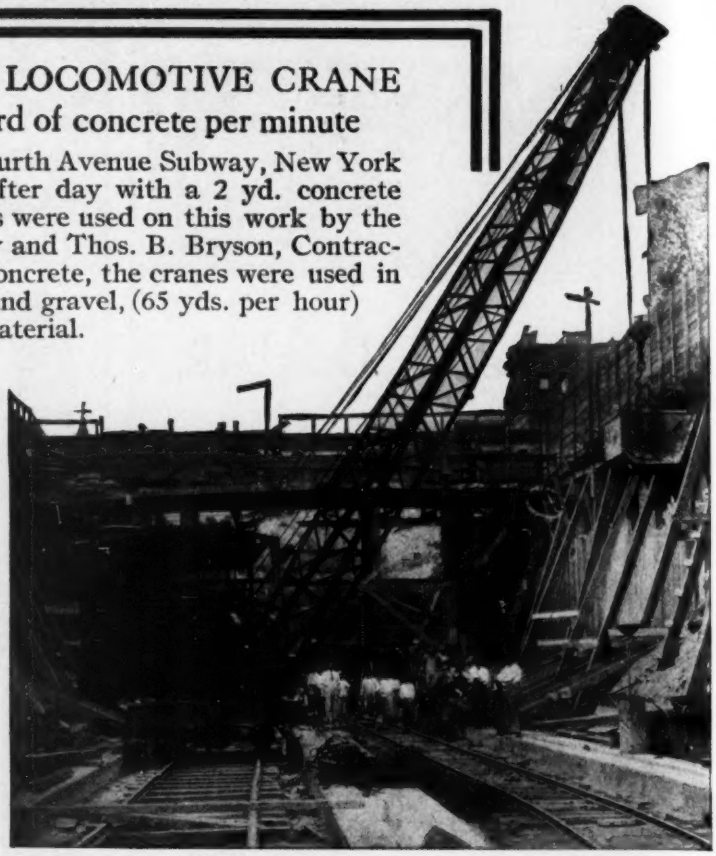

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FOR many a contractor must have a locomotive crane for structural steel and general construction work *part of the time*, for digging *part of the time*, for pile-driving *part of the time*. He cannot keep three separate machines busy all the time, but one machine capable of doing all three would never be idle a day. **Every Such Contractor Needs**

The McMyler Interstate 25 or 35 Ton Crane

Because the "McMyler-Interstate 25 or 35" is capable (1) of handling structural steel and general contracting work, (2) of working with drag scraper, Clam Shell and Orange Peel Buckets, and (3) of use with pile-driver attachment.

Because it can be easily transported from one point to another over any standard gauge railroad.

Because on any one of these jobs a "McMyler Interstate 25 or 35 ton" is unequaled for all round efficiency and economy.

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The "25 and 35-ton McMyler-Interstate" is equipped with boom up to 70 ft. in length by the simple process of disconnecting the two pin connections of the leader truss and putting boom in place.

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The same machine can be fitted with a Scraper Bucket or any type of two-line Clam Shell or Orange Peel Bucket, as well as a Magnet, if desired. This machine has been tried out; is of the foremost type in each of its forms, and a most valuable part of the equipment for any Railroad, large or small.

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Locomotive cranes—all types of standard and broad gauge Scraper Excavators, Clam Shell and Orange Peel Buckets, Coal and Ore Handling Machinery, Railroad Pile Drivers. Glad to send you a catalog on any, or all of these lines.

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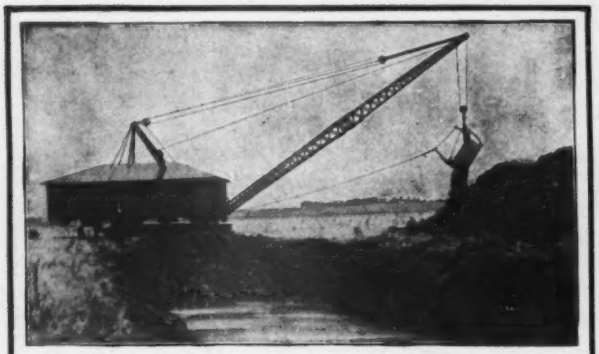

The Gasoline Power Drag Line Excavator

Look at that illustration. It looks like an ordinary steam power drag line e cavator, doesn't it, except that it has no smoke stack?

That's the gasoline power Monighan Steel Drag Line Excavator, the *first* successful drag line excavator to be run by gasoline power.

Every contractor knows that in many excavating jobs, conditions have required such a machine as this—and here it is at last to fill that need.

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The bucket that is as nearly as possible indestructible. No higher in price that any other *good* bucket.

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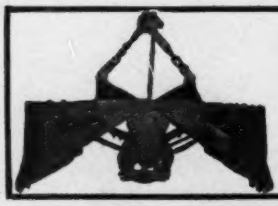

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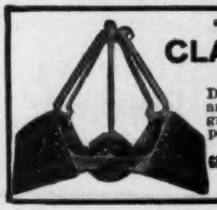

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CLAM SHELL BUCKETS
Made Entirely Of Steel
Digging qualities superior owing to shape of shell and increased leverage. Adapted for handling sand, gravel, broken stone, coal, excavating when equipped with teeth. Used by largest R. R. and contractors.
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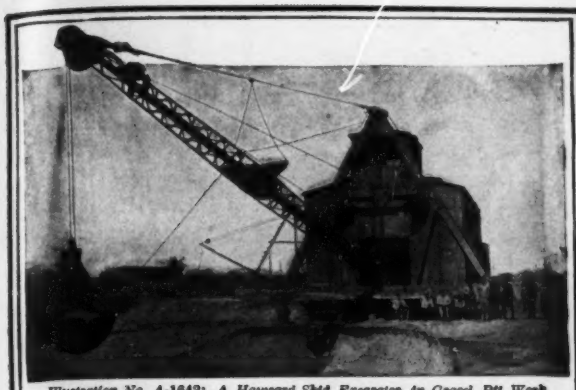

Illustration No. A-1642: A Hayward Skid Excavator in Gravel Pit Work, operated by the Vandalia Railroad Company at Terre Haute, Ind.

HAYWARD BUCKETS

Orange Peel Clam Shell Drag Scraper have no equal. Full information given in Bucket Catalogue No. 39 and Digging Machinery Catalogue No. 40 which will be sent on request.

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"Excelsior" Bottom Dump Concrete Bucket (Patented)

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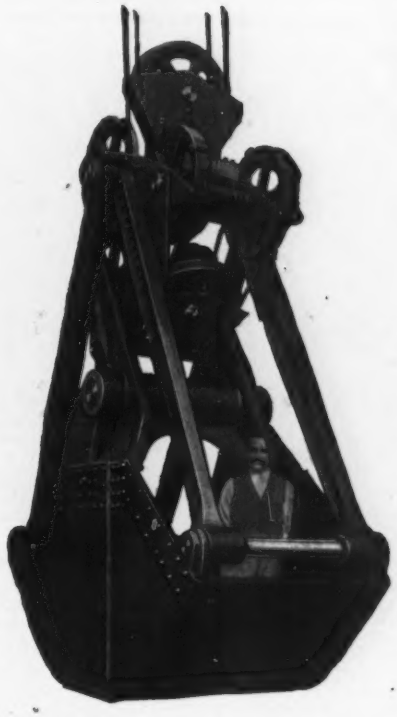

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The Dunbar & Sullivan Dredging Co., the firm doing the work, have written in an enthusiastic letter on Williams superiority. In digging hard clay deposits or in ordinary every-day work, as well as in deep water dredging, these buckets have proved that they are highly efficient and have lasting strength.

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Our ten sizes of pile hammers cover all kinds of driving from the lightest wood and steel sheeting to the heaviest concrete piles weighing up to 36 tons each.

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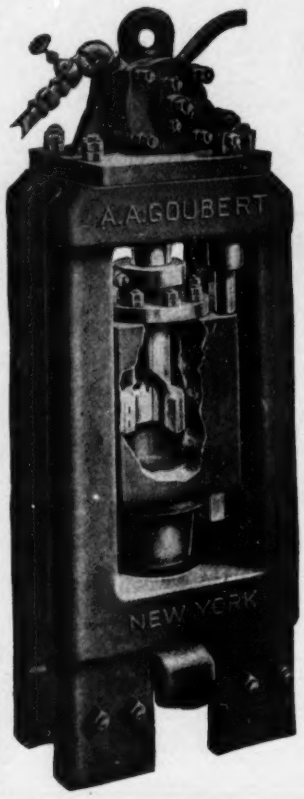

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The cylinder is the ram that strikes the blow.

Made all of steel—practically indestructible.

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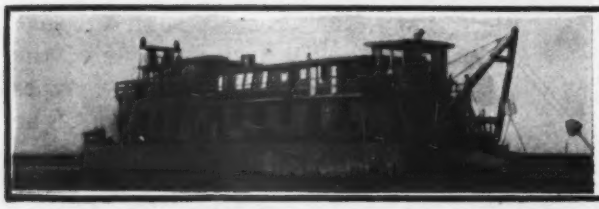

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made to meet just *your* requirements. We can increase your present output—we can save money for you. Let us tell you what we've done for others—let us show how we'll help you. **Write to us.**

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Complete Elevating, Hoisting and Handling Equipments designed and installed. Locomotive Cranes.

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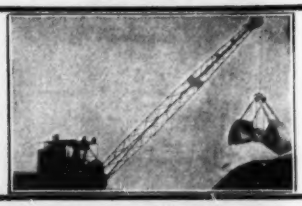

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Simplest Ever Made

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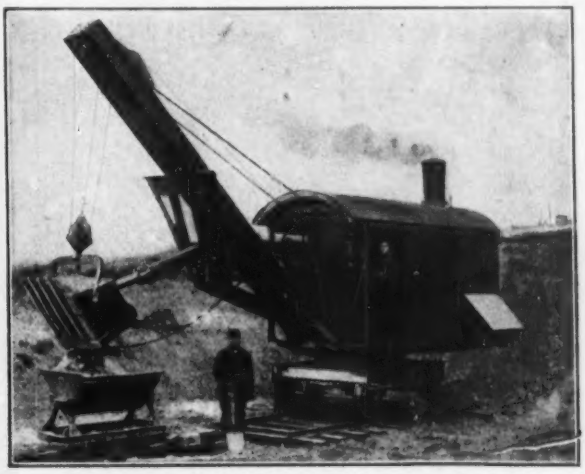
FULL CIRCLE SWING STEAM SHOVEL



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A feature that adds largely to its efficiency is the full circle swing. The shovel swings through a complete circle, delivering the excavated material at any desired point, either at the side or rear of the machine. The shovel can be easily moved from one working place to another and can enter the work in any desired direction.

All Standard Thew Shovels are equipped with the Horizontal Crowding Motion, a distinct advantage, which makes it practicable to operate with economy in very shallow cuts.

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We fully guarantee our shovels as regards material and workmanship, and agree to replace without cost any parts proving defective within six months after delivery.

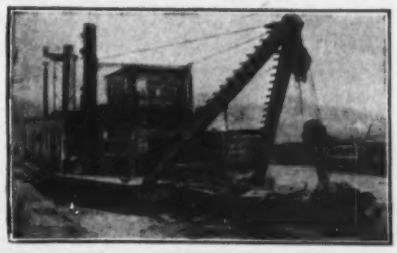
Our catalogue will show you how to save money on that job of yours.

Just write for it now *while it's on your mind*

The Thew Automatic Shovel Company

LORAIN, OHIO

46 Years' Experience Back of Morris Hydraulic Dredges



The advantages of the hydraulic method are well recognized. By dredging and carrying away sand, gravel and small boulders in one operation, economy of time and labor is effected and capacity increased. Morris Hydraulic Dredges are unexcelled in this work. We are prepared to furnish a full requirement.

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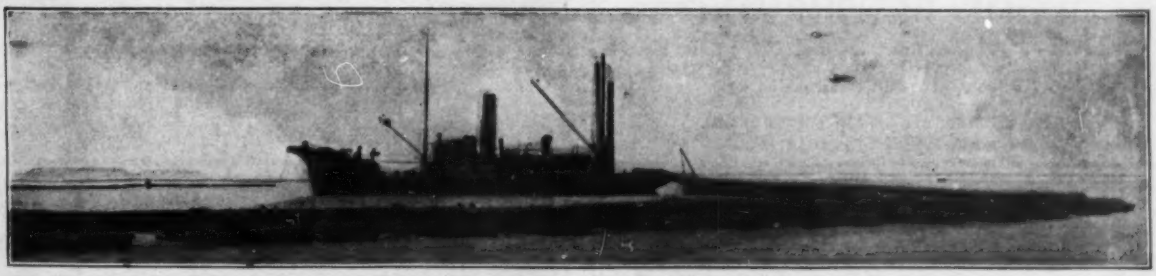

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The woodwork of this great dam is preserved with

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a wonderfully efficient preservative made with scientific accuracy, that has greater penetrating power and greater antiseptic power than any other preservative. Penetrating power is the first requisite for wood preservation. If a preservative cannot penetrate it does not preserve. Conservo goes into the wood deeper and more quickly than any similar compound and more thoroughly sterilizes and preserve the wood. It is sold at a reasonable price, (about one-half that of heavy, viscous, non-penetrating carbolineums) and can be applied hot or cold. Catalogue and full details on request.

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In Volume Is Profit

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Order now and take advantage of the exceedingly low prices.

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Creosoted cross arms, Lumber, Paving Blocks, Piles, Poles and Ties.
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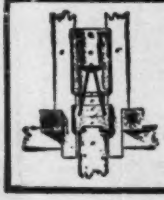

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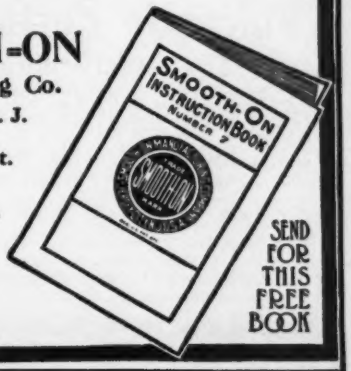

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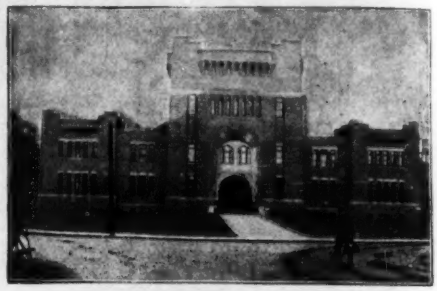

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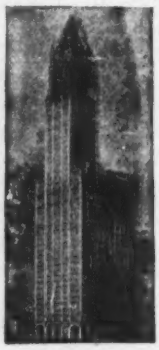

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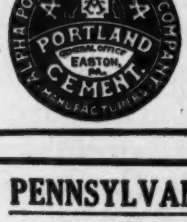

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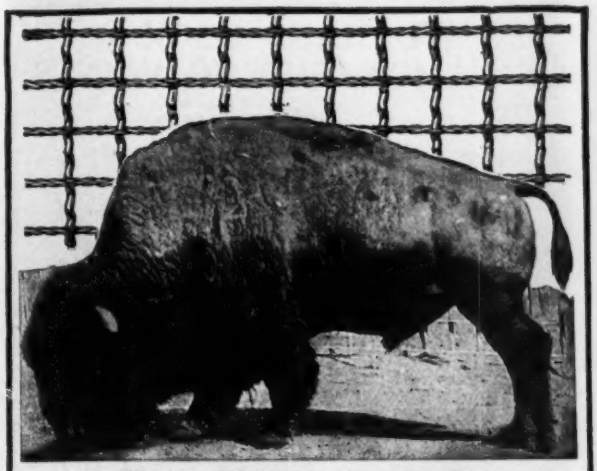

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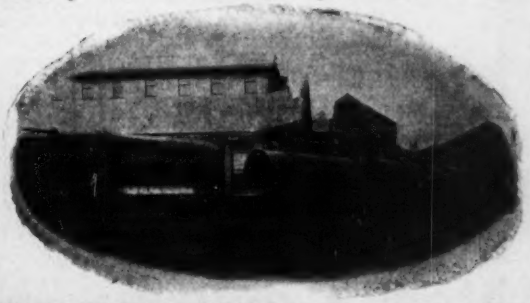

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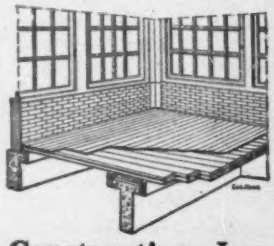

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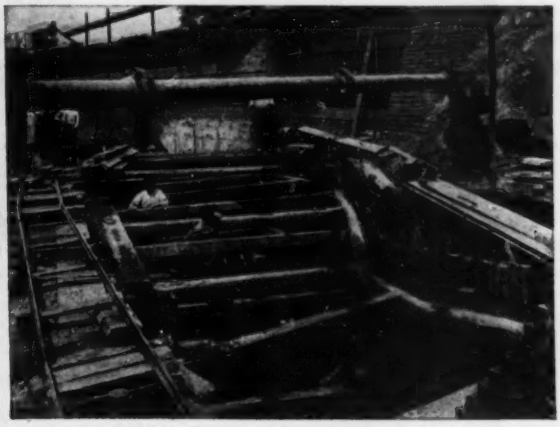

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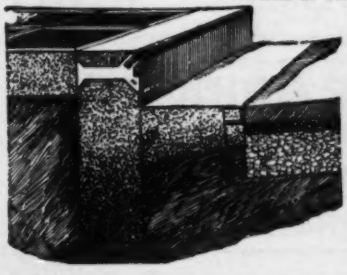

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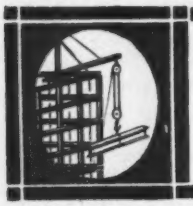

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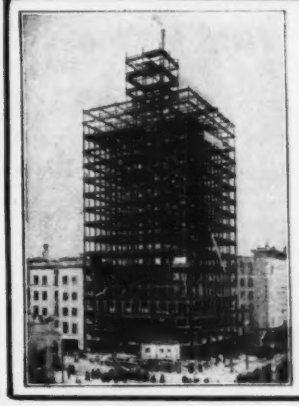

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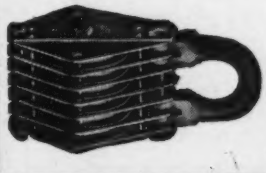

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WASHINGTON: Rosslyn Supply Co., Colorado Building
CHICAGO: Clinton Wire Cloth Co., 342 River Street

L. A. NORRIS CO.
835 Monadnock Bldg., San Francisco
BRANCHES:
Los Angeles Seattle
Portland, Ore. Vancouver, B. C.

Partitions

$Dolarway Pavement

"It is permanent because it is concrete."

SOLVES THE CONCRETE PAVING PROBLEM

UNTIL the advent of Dolarway, the success of concrete pavements was questioned. They were perfect in theory but did not work out in practice.

A few years ago the first Dolarway Pavements were laid in Ann Arbor, Michigan, and the problem of satisfactory concrete pavements was solved. The solution was as simple as it is satisfactory.

Over the concrete was spread a thin layer of Dolarway bitumen. This made the ideal plastic surface, without which concrete pavements had not been entirely satisfactory. The surface is not only inexpensive but its renewal costs very much less than the maintenance costs of any other form of pavement.

This thin sheet of Dolarway bitumen has proven ample to protect the concrete from fracture by traffic or damage by water or frosts. In fact, as long as the bitumen is maintained the concrete shows no wear or deterioration.

The Dolarway method reduces the cost on permanent pavements 50c to $1.00 per square yard.

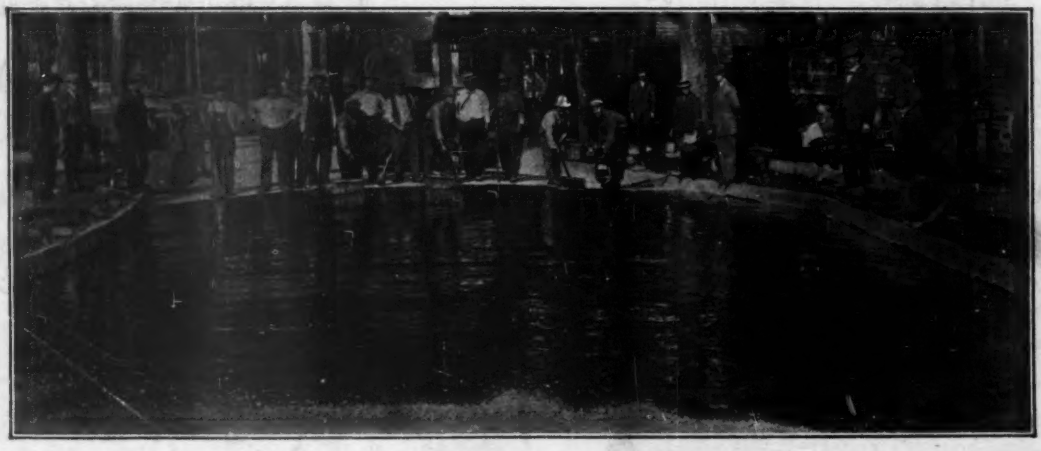
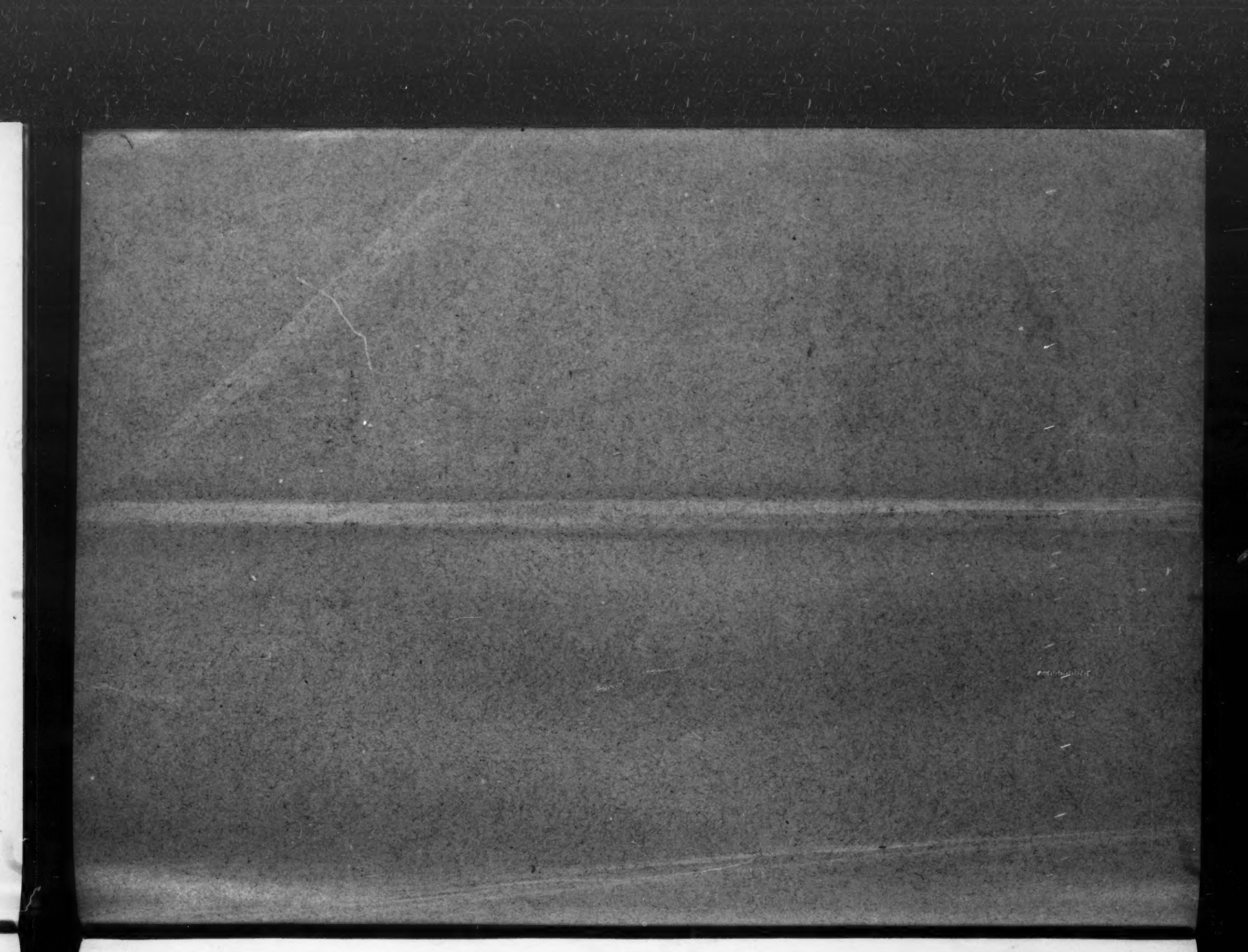
The pavement presents a handsome surface; it is quiet under traffic; no dust or mud is produced; no damage by oil drippings or thrusts from automobile wheels. It makes a most satisfactory cushion for horses.

Dolarway is the ideal material to pave between and adjoining street car tracks. Dolarway is good enough for city streets and cheap enough for country roads.

Further details on request.

DOLARWAY PAVING COMPANY

95 Liberty Street, New York City



Applying Dolarway Bitumen on Concrete Base, Gloversville, N. Y.